REMEDIAL ACTION PLAN

FI KANSAS REMEDIATION TRUST
FORMER FARMLAND INDUSTRIES
NITROGEN PLANT
1608 N. 1400 ROAD
LAWRENCE, KANSAS

May 22, 2009

Prepared For:

FI KANSAS REMEDIATION TRUST
SELS Administrative Services, LLC, Trustee

Prepared By:

Shaw Environmental, Inc.
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EXECUTIVE SUMMARY

The former Farmland Industries Nitrogen Manufacturing Plant in Lawrence, Kansas (Site) began operations in 1954, producing a wide range of nitrogen-based fertilizers. The plant was expanded and updated during its history to provide a variety of fertilizer products, including anhydrous ammonia, nitric acid, granular urea, ammonium nitrate, and urea ammonium nitrate (UAN) solution. The production areas at the plant consisted of a wide variety of structures and buildings. In addition to the production areas, the facility operated diverse support and ancillary functions, including but not limited to boilers, waste water treatment, waste disposal units, and facility maintenance. All operations ceased at the facility in 2001 because of the economic downturn of the fertilizer market, rising energy costs, and the eventual bankruptcy of Farmland Industries in 2002.

In 2004, following approval of Farmland Industries’ Plan of Reorganization by the Bankruptcy Court and concurrence from United States Environmental Protection Agency (EPA) and Kansas Department of Health and Environment (KDHE), the FI Kansas Remediation Trust (Trust) was formed and funded with approximately $7.0 million (initial remediation fund) to address the remaining environmental impairments at the Site. In 2006, the Trust was funded with approximately $7.8 million (initial administrative fund) to facilitate the sale and manage the administrative activities of the Site.

The Trust, through SELS Administrative Services, LLC as Trustee, manages the environmental and administrative functions of the Site. The Trust retained Shaw Environmental and Infrastructure, Inc. (Shaw) to help manage the mandated compliance and cleanup of the Site in close cooperation and supervision with KDHE and EPA.

BACKGROUND

The Site encompasses an area of approximately 467 acres in Douglas County, Kansas, and is bounded on the north by 15th Street and the Burlington Northern Santa Fe Railroad. The remaining Site property lines border undeveloped and developed industrial property on the east, mixed commercial and residential areas on the west, and State Highway K-10 on the south.

The Site has undergone several episodes of environmental investigation since the 1970’s. Early investigations focused on groundwater and soil impacts related to the ponds, located in the northern portion of the Site, and storm water runoff from process areas. Preliminary remedial actions in the form of groundwater interception trenches were implemented in the late 1970’s. In the 1980’s, the Chromium Reduction System (CRS) at the Site was identified as a RCRA facility. A RCRA Surface Impoundment Closure Certification was completed in 1987, and a Post Closure Care Permit was issued in 1993.

A RCRA Facility Assessment (RFA) was completed in September 1990 and identified 21 solid waste management units (SWMUs) and four Areas of Concern (AOCs). Farmland and KDHE entered into a Consent Agreement (Consent Order Case No. 92-E-27) on January 27, 1993 to conduct a Comprehensive Investigation/Corrective Action Study (CI/CAS). This investigation was completed with the submittal of the CI report characterizing the 21 SWMUs and identified AOCs in January 1994, and a supplemental report was completed in October 4, 1994. In 1997, a Corrective Action Plan (CAP) was approved by KDHE with a request that Farmland Industries install a French Drain system and recovery wells in the northern part of the Site, including reusing/recycling contaminated groundwater in plant processes. After termination of plant operations in 2001, the recycle/reuse assumptions were no longer
applicable, and KDHE requested that the Trust perform additional investigations and develop a modified remedy.

A full Site Characterization was conducted in 2005, with the collection of environmental data to identify the lateral and vertical extent of the targeted analytes identified in the 1990 RFA report. Based on the accumulated environmental data, an Interim Measures Plan was approved in April 2006 to mitigate high priority portions of the environmentally-impacted areas.

The interim measures have included planning and implementation of a land application program to discharge nitrogen impacted groundwater and storm water. The Trust also excavated and disposed of approximately 32,000 cubic yards of soils, sediments, and wastes from various areas of the Site. This includes approximately 15,000 cubic yards of sediment that were removed from the Overflow Pond and placed in the Rundown Pond. Other interim measures have included modifications to storm water drainage to segregate storm water runoff impacted with nitrogen compounds for use in the land application program, piping modifications to the groundwater containment system to allow groundwater impacted by nitrogen compounds captured by the interceptor trenches to be pumped directly to the above-ground storage tanks (ASTs) for use in the land application program, and inspection, cleaning, and repair of the large AST used in the land application program.

Groundwater across the Site has been divided into four units, three of which – the overburden unit, the bedrock unit (most notably in the Sandstone Hill), and the silty clay unit underlying the ponds in the northeast portion of the Site – do not have significant potential for economic water production. The only aquifer with potential for sustainable groundwater yield is the Kansas River alluvial aquifer that borders the north edge of the Site. All four of the water-bearing units identified at the Site contain nitrate impacts. The largest mass of nitrate and ammonia in groundwater and soil is located in the northern portion of the Site, specifically in the Northeast Production Area and the Area B Ponds.

CLEANUP GOALS AND OBJECTIVES

Following the comprehensive Site Characterization and completion of several interim remedial measures, KDHE authorized the Trust to proceed with preparation of the Remedial Action Plan (RAP). The overall cleanup goal for the Site is full closure and unrestricted property use. However, given the nature and extent of impacts, it is not possible to implement a remedial strategy which achieves this closure goal in the near term and within the financial limitations of the Trust. For this reason, in correspondence dated August 26, 2008, KDHE established priorities for remedial activities to be undertaken at the Site.

The objective of the RAP is to provide a comprehensive plan and ensure available funding for maintenance and remediation of the Site within the context of the priorities established by KDHE, EPA, and the Trust. The overall clean up goal for the Site is unrestricted use. However, based on the current industrial setting of the Site, which can be controlled through land use restrictions (LURs), non-residential Risk-Based Standards for Kansas (RSK) screening values have been applied to the Site.

This RAP includes a summary of investigations and remediation-related activity previously carried out at the Site, identifies environmental issues that require further action, evaluates remedial alternatives, identifies priorities, proposes remedial actions, and provides cost estimates to implement the proposed remedies. The primary contaminants at the Site are nitrate-nitrogen (nitrate) and ammonia-nitrogen (ammonia). Nitrate and ammonia are present in the soil, groundwater, surface water, and sediment at varying concentrations throughout the Site. In addition, arsenic is present in some pond sediment and in groundwater samples at concentrations that exceed applicable remediation goals.
There are currently no screening or cleanup standards based on direct contact with nitrate in soil. However, KDHE has developed RSK values for nitrate plus ammonia in surface and subsurface soils based on protection against soil impacts leaching to groundwater. The nitrate plus ammonia standard varies depending on depth and ground cover, relating to the potential for uptake by plants. The most restrictive scenario for nitrate plus ammonia is soil below the root zone which can leach to groundwater and for which the RSK value is 40 milligrams per kilogram (mg/kg) nitrate plus ammonia.

Human health risk calculations performed by USEPA (memorandum dated December 1, 2008) have shown that ammonia in soil can pose a risk to human health under certain direct exposure scenarios. The most restrictive preliminary remediation goal (PRG) calculated by EPA is 385 mg/kg ammonia for a construction worker exposure scenario using a non-cancer hazard quotient of 1.

The drinking water maximum contaminant level (MCL) for nitrate in groundwater is 10 milligrams per liter (mg/l). Nitrate in groundwater is well-documented in the monitoring well network at the Site. An RSK value or an MCL has not been established for ammonia in groundwater.

Arsenic has been detected in groundwater and pond sediment in limited areas of the Site at concentrations above the non-residential RSK standards (38.0 mg/kg for soil/sediment and 0.01 mg/L for groundwater). The observed arsenic concentrations may be a result of natural soil or rock weathering and leaching processes. Furthermore, the areas where arsenic has been detected above RSK values are in areas that will be addressed through active measures (pond closure and capping), groundwater pumping (groundwater containment system), or through proposed land-use restrictions as a result of nitrate and ammonia concentrations.

Other constituents, including fuel and solvent compounds, other metals, and polychlorinated biphenyl compounds, have also been detected at the site. Because of the infrequency of detection of these other constituents and the fact that most were detected at concentrations below the non-residential Risk-Based Standards for Kansas values used for comparison at this site, these other constituents are not further discussed in this RAP. Detailed information concerning historical contaminant detections at the site is included in various investigation documents, particularly the 2005 Site Characterization Report, available for review at KDHE’s Topeka office.

REM EDIAL ACTION PLAN

Areas of the Site not previously remediated by interim actions will be addressed by remedial actions developed and evaluated in the RAP within the context of remedial priorities established by KDHE. The RAP also includes an evaluation of remedial alternatives, along with a discussion of advantages and disadvantages to each alternative. Cost estimates were developed for each alternative as a part of the evaluation process.

Remedial actions were prioritized based on several issues: 1) the responsible party (Farmland Industries) has been dissolved through federally-administered bankruptcy; 2) there is a limited amount of funding available in the Trust to remediate all environmental contamination issues at the property; 3) land use of the property will remain as non-residential; and 4) the Trust is interested in selling the property for future redevelopment.

The remedial actions identified for the Site fall into the following three categories:

1. Primary Remedial Priorities – remedies to be either continued and/or implemented immediately using funding from the Remediation Trust:
a. Continue operation and enhancement of the groundwater monitoring network;

b. Continue operation and enhancement of the groundwater containment system at the site including land application of impacted water, to the extent it is feasible, for a minimum period of 30 years;

c. Record and file with the County Register of Deeds Office LURs to control future uses and activities at the Site; and

d. Continue Post-Closure Care monitoring of the CRS Unit in accordance with the requirements of the KDHE Bureau of Waste Management.

2. Development Priorities - to be implemented in coordination with future site development plans or, if the property is not sold within five years, by funding from the Administrative Trust:

   a. Modify infrastructures, operations, and maintenance of storm water management systems to meet the needs of future development plans and maintain current NPDES requirements. This includes removal of sludge from the East and West Effluent Ponds so they can be utilized for future non-contact storm water detention.

3. Secondary Remedial Priorities – to be implemented based on available funding in the Remediation and Administrative Trusts or by a prospective purchaser through financial assurance:

   a. Excavation and management of impacted soils in select areas of the Site to improve storm water runoff quality;

   b. Excavation and management of impacted soils to accommodate future development or construction;

   c. Final closure of the northern ponds, including the Overflow Pond.

PRIMARY REMEDIAL PRIORITIES

The first remedial priority is maintaining hydraulic control of groundwater impacted by nitrogen compounds by utilizing the existing groundwater containment system and implementing certain enhancements, disposing of the impacted water (including impacted storm water runoff) through the existing land application system, and continuing to monitor contaminant migration using the existing groundwater monitoring network. The existing groundwater containment system was initially installed in 1975, expanded in 1995, and expanded again in 1998. The groundwater containment system currently consists of 5,200 feet of interceptor trench with five sumps, and three deep recovery wells. The system is operated continuously and is monitored on a quarterly basis by a network of wells. Recovered water that is most heavily impacted with nitrate and ammonia is stored in 6-million gallon and 2-million gallon tanks and is land applied on farm fields north of the Site and the Kansas River for beneficial use of the nitrogen content. The groundwater containment system has been effective in maintaining hydraulic containment of the impacted groundwater and in preventing deterioration of the alluvial aquifer that exists beyond the Site boundary to the north.

As a result of the limitations of Trust funds, moderate to high levels of nitrogen compounds (nitrate, nitrite, and ammonia) will remain in the subsurface at the Site for an extended period of time. Therefore, continued operation of the enhanced groundwater containment system for a minimum period of 30 years
is required to ensure groundwater impacted by nitrogen compounds does not migrate off-site and impact downgradient water resources.

Although the existing operating groundwater containment systems are effectively capturing shallow groundwater and inhibiting migration into the deeper alluvial aquifer in the north and northeast portions of the Site, two potential inadequacies were identified in the existing system as presently configured. A new alluvial aquifer recovery well and five additional monitoring wells are proposed to provide enhanced groundwater capture and protection of the alluvial aquifer in the northwest portion of the site. The containment of impacted surface and ground water will also be enhanced by construction of a surface and shallow groundwater interceptor trench in the Sandstone Hill Central Pond area and a sump to collect surface water from the Dam Pond. Water captured in these two structures will be stored for use in the land application program.

The second remedial priority is the continued operation of the land application program for management and disposal of impacted surface water and groundwater. Following shutdown of the plant, storm water and recovered groundwater that contained concentrations of nitrogen compounds above the NPDES discharge permit levels could no longer be recycled in plant processes and have instead been contained on-site in two existing ASTs and the Rundown and Overflow Ponds. Initially, this water was transported to agricultural fields located north of the Site and land applied on crops for the beneficial use of the nitrogen compounds in the water as fertilizer. Beginning in 2005 the water was pumped from the Site through existing piping to agricultural fields north of the Kansas River. To date approximately 71.3 million gallons of impacted water have been land applied, removing an estimated 2,224,200 pounds of nitrogen from the Site for beneficial use. The amount of water that a field can receive is dependent on several factors, including the concentration of nitrate in the water, prevailing moisture conditions in the field, and time in the growing season. It is highly likely that a point in time will be reached when the land application for beneficial use of the nitrogen compounds in the water will no longer be economically feasible because of lower nitrate concentrations and the resultant increase in water volumes required to deliver the desired mass of nitrogen.

The third remedial priority involves the use of land-use restrictions (LURs) to control certain activities and uses of the Site. Because of the large volume of soil impacted by former plant operations, the relative lack of health risks associated with nitrogen compounds at the Site, and limited financial resources available for remediation, select areas of the Site will be addressed through the application of LURs. The LURs will prevent the movement of impacted soils or extraction of impacted groundwater without proper management. LURs will be obtained through KDHE’s Environmental Use Control (EUC) program. A soil management plan will be developed through the EUC program and will be available to future users of the property to provide guidance in the handling and movement of soil potentially containing elevated concentrations of nitrogen compounds or metals.

The final primary remedial priority is the continued monitoring of the Chromium Reduction System (CRS) Unit. The CRS Unit was constructed and operated from 1972 to 1984 to remove hexavalent chromium from water, which had been circulated through cooling towers to inhibit corrosion. Closure of the CRS was accomplished in 1986 and early 1987 under a RCRA Closure Plan approved by the KDHE. A RCRA permit for Post Closure Care was jointly issued by the KDHE and USEPA Region VII in February 1993 and was renewed in 2002 to continue the Post-Closure Care monitoring. As groundwater pH is the only remaining compliance issue for the CRS Unit and chromium has not been detected in the monitoring wells, the Trust and the KDHE have concurred that the CRS Unit may be clean-closed following mitigation of the low pH condition. Post-Closure Care monitoring and reporting will continue on a reduced
schedule until the low pH condition is mitigated, as described in correspondence from KDHE dated October 17, 2008.

**DEVELOPMENT PRIORITIES**

Storm water management and monitoring is an important aspect of the overall management of environmental issues at the Site. Storm water exiting the Site is currently discharged through on-site ditches and ponds to the Kansas River. This also includes storm water coming on the Site from the south, including runoff from Highway K-10 as well as from land south of Highway K-10. Because of limitations of the Remediation Trust, storm water management improvements will be funded as part of the future development of the property or, if the property is not sold within five years, by funds in the Administrative Trust.

The only area of the Site where storm water has been shown to be impacted significantly by nitrogen compounds is in Area A (Sandstone Hill) at the north end of the Site. Area A continues to impact storm water with contact to nitrogen impacted surface soils and nitrogen impacted groundwater that appears at the surface as seeps. The major components of the proposed storm water management system are: 1) desludging of the East and West Effluent Ponds so that they may be used for detention of non-contact storm water; and 2) construction of a new storm water drainage ditch, berm, weir structure, detention basin, and discharge pump.

Storm water monitoring and NPDES permit monitoring is assumed to be required for a period of 8 years following approval of the RAP. Management and monitoring of the storm water will continue as outlined in the Storm Water Management Plan (SMP) submitted to KDHE in 2006. Storm water with concentrations of nitrogen compounds above NPDES limits, primarily from Area A, will be segregated and collected in the Overflow Pond for future use in the land application program. Once the new storm water drainage ditch and detention basin are constructed and have reached acceptable quality as a result of the segregation of impacted storm water, storm water and discharge monitoring will no longer be required.

**SECONDARY REMEDIAL PRIORITIES**

Remedial activities that are not within the funding capabilities of the Remediation Trust are identified as Secondary Remedial Priorities. These actions will enhance and expedite the overall remediation of the Site. These actions are required by KDHE and will be completed either through remaining funding from the Remediation or Administrative Trusts, through financial assurances obtained by the purchaser of the Site, and/or through funds generated by redevelopment of areas of the Site.

Secondary remedial priorities include remediation of Sandstone Hill soils, Central Ponds soils, Dam Pond sediments, Krehbiel and West Pond sediments, and Area A and Area D soils. Other secondary priorities are closure of Area B Ponds, plugging of production wells, and development of remedial design documents.

**REMEDIAL ACTION COSTS**

The total estimated cost for implementation of the primary, developmental, and secondary remedial priorities at the Site as of May 22, 2009 is approximately $13.2 million. This amount includes approximately $5.1 million for implementation of the three primary remedial priorities, $1.8 million to support the future development efforts, $3.7 million to implement the secondary priorities, $2.1 million in contingency, and $0.5 million for KDHE oversight cost. The remaining balances of the Remediation Trust and Administrative Trust as of April 30, 2009 are approximately $4.31 million and $6.17 million, respectively.
The estimated costs for long-term operation and maintenance tasks are based on historical costs with allowances provided for equipment replacement/repair over the assumed 30 year project life. Estimates for removal actions and pond closure activities are based on recent cost data from similar efforts at the Site. The implementation strategy for these remedial actions will include the competitive bidding of subcontracted services required to complete the actions in the most cost-effective manner. Economies of scale may also assist in cost-effective pricing through packaging of several tasks. It should also be noted that the estimated cost does not take into account the time value of money, and therefore, all future costs are valued as present costs.

Site development can be coordinated with remedial efforts to reduce the overall remedial costs of the secondary priorities. Site development can also help to improve Site conditions in a quicker fashion than has been estimated in this RAP which could reduce long-term operation and maintenance costs over the 30 year project life. It should also be noted that the three primary remedial priorities are estimated based on 30 years of operation and maintenance. It is conceivable that upon Site development, the land application program will be reduced and/or totally eliminated, resulting in significant cost savings.

The ultimate cleanup goal to allow unrestricted use of the property will not occur in the short-term because of the financial limitations of the Trust and the large areas needing active remediation. However, it is expected that through the implementation of the strategies presented in this RAP coupled with natural degradation processes, as well as future development activities, the Site will eventually be restored to a condition allowing unrestricted use.
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<th>Description</th>
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<tbody>
<tr>
<td>ACM</td>
<td>Asbestos-containing material</td>
</tr>
<tr>
<td>Ammonia-N</td>
<td>Ammonia-nitrogen</td>
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<tr>
<td>AOC</td>
<td>Area of concern</td>
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<tr>
<td>AOI</td>
<td>Area of interest</td>
</tr>
<tr>
<td>As</td>
<td>Arsenic</td>
</tr>
<tr>
<td>AST</td>
<td>Above-ground storage tanks</td>
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<tr>
<td>ATSDR</td>
<td>Agency for Toxic Substances and Disease Registry</td>
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<tr>
<td>Ba</td>
<td>Barium</td>
</tr>
<tr>
<td>bgs</td>
<td>Below ground surface</td>
</tr>
<tr>
<td>BNSF</td>
<td>Burlington Northern Santa Fe Railroad</td>
</tr>
<tr>
<td>CD</td>
<td>Compact disk</td>
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<tr>
<td>Cd</td>
<td>Cadmium</td>
</tr>
<tr>
<td>CAP</td>
<td>Corrective Action Plan</td>
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<tr>
<td>CI</td>
<td>Comprehensive Investigation</td>
</tr>
<tr>
<td>CAS</td>
<td>Corrective Action Study</td>
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<tr>
<td>CWA</td>
<td>Clean Water Act</td>
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<tr>
<td>Cr</td>
<td>Chromium</td>
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<td>CRS</td>
<td>Chromium Reduction System</td>
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<tr>
<td>cy</td>
<td>Cubic yards</td>
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<tr>
<td>DWR</td>
<td>Division of Water Resources</td>
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<tr>
<td>EP</td>
<td>Extraction procedure</td>
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<tr>
<td>FDS</td>
<td>French drain system</td>
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<tr>
<td>FI</td>
<td>Farmland Industries</td>
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<tr>
<td>FSP</td>
<td>Field Sampling Plan</td>
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<tr>
<td>gpm</td>
<td>Gallons per minute</td>
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<tr>
<td>GPS</td>
<td>Global positioning system</td>
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<tr>
<td>HDPE</td>
<td>High-density polyethylene</td>
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<tr>
<td>Hg</td>
<td>Mercury</td>
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<td>IRIS</td>
<td>Integrated Risk Information System</td>
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<tr>
<td>IRM</td>
<td>Interim remedial measures</td>
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<tr>
<td>KDA</td>
<td>Kansas Department of Agriculture</td>
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<tr>
<td>KDHE</td>
<td>Kansas Department of Health and Environment</td>
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<tr>
<td>KGS</td>
<td>Kansas Geological Society</td>
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<tr>
<td>KSU</td>
<td>Kansas State University</td>
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<tr>
<td>LUR</td>
<td>Land-Use Restriction</td>
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<tr>
<td>MCL</td>
<td>Maximum Contaminant Level</td>
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<tr>
<td>MEK</td>
<td>Methyl ethyl ketone</td>
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<tr>
<td>MFL</td>
<td>Magnetic flux leakage</td>
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<tr>
<td>mg/L</td>
<td>Milligrams per liter</td>
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<tr>
<td>mg/kg</td>
<td>Milligrams per kilogram</td>
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<tr>
<td>MSDS</td>
<td>Material safety data sheet</td>
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<tr>
<td>MSL</td>
<td>Mean sea level</td>
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<td>NE</td>
<td>Northeast</td>
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NFIP  National Flood Insurance Program
NH₃-N  Ammonia-nitrogen
Nitrate-N Nitrate-nitrogen
NO₃-N Nitrate-nitrogen
NOI Notice of Intent
NPDES National Pollutant Discharge Elimination System
NW Northwest
O&M Operation and maintenance
Pb Lead
PCB Polychlorinated Biphenyls
PCE Perchloroethylene
RAP Remedial Action Plan
RCRA Resource Conservation and Recovery Act
RFA RCRA Facility Assessment
ROM Rough order-of-magnitude
RSK Risk Based Standards for Kansas
SCR Site Characterization Report
Se Selenium
SE Southeast
Shaw Shaw Environmental and Infrastructure, Inc.
Site The former Farmland Nitrogen Manufacturing plant in Lawrence, Kansas
SMP Storm Water Management Plan
SMMP Storm Water Management and Monitoring Plan
SW Southwest
SWMU Solid Waste Management Unit
TCLP Toxic Characteristic Leachate Procedure
TKN Total Kjeldahl nitrogen
Total Nitrogen Nitrate plus Nitrite + Ammonia as Nitrogen
TPH Total Petroleum Hydrocarbons
TPH as DRO Total Petroleum Hydrocarbons as Diesel Range Organics
TPH as GRO Total Petroleum Hydrocarbons as Gasoline Range Organics
TPH as FP Total Petroleum Hydrocarbons as Fuel Product
Trust FI Kansas Remediation Trust
UAN Urea-ammonium nitrate
USEPA United States Environmental Protection Agency
UT Ultrasonic thickness
VOC Volatile organic compounds
μg/L micrograms/liter
USDA United States Department of Agriculture
WCC Woodward-Clyde Consultants
WHO World Health Organization
1.0 INTRODUCTION

The former Farmland Industries Nitrogen Manufacturing plant in Lawrence, Kansas ("Site") began operations in 1954 and produced over its operating period various nitrogen-containing chemicals that included ammonia, urea, nitric acid, ammonium nitrate, and urea-ammonium nitrate solution (UAN). All manufacturing operations were shut down in 2001 when the plant was closed due to the economic downturn of the agricultural fertilizer market, rising energy costs, and the eventual bankruptcy of Farmland Industries. On December 29, 2003, the Bankruptcy Court approved the Plan of Reorganization which created the FI Remediation Trust ("Remediation Trust") and the Administrative Trust. The Kansas Department of Health and Environment ("KDHE") was named as the "Primary Beneficiary" of the Remediation Trust. The Remediation Trust was established to manage the administration and environmental remediation activities for Farmland's property located in the State of Kansas. In keeping with its secondary duty under the Trust Agreement, the Trust is the current owner of the Site and is charged with selling the Site for future redevelopment. As of April 30, 2009, the total funding in the Remediation Trust was $4.31 million and in the Administrative Trust was $6.17 million. This funding fluctuates based on the market conditions.

As a result of nearly 50 years of operation, environmental concerns associated with the operation of the facility have been evaluated during multiple phases of investigation and addressed by a number of completed and on-going cleanup actions. Based on these investigations it was determined that approximately 302 acres of the Site (including the approximately 30 acres of farm ground north of the railroad tracks and south of 15th Street) were not grossly impacted by contamination from operations at the facility. These 302 acres will likely not need remediation but will be subject to Site-wide land-use restrictions ("LURs") which include limiting residential zoning and the installation of groundwater wells for drinking water on the Site. Additional LURs will be necessary in specific areas of the Site based on site conditions and remedial measures.

The remaining areas of the Site, including the primary operational areas, were investigated to determine if they require remedial action and/or on-going maintenance. The Trust retained Shaw Environmental and Infrastructure, Inc. ("Shaw") to develop and execute remedial alternatives for the Site. Current remedial actions and evaluation of proposed remedial measures are being performed under the oversight of the KDHE - Bureau of Environmental Remediation ("BER"), Bureau of Water ("BOW"), Bureau of Waste Management ("BWM") and the United States Environmental Protection Agency ("EPA").

KDHE’s overall remediation goal for the Site is cleanup to allow unrestricted property use. However, given the nature, extent, and depth of environmental impacts, it is not possible to implement a remedial strategy which achieves the overall remediation goal in the near term within the limitations of the available Trust funds. For this reason, KDHE, USEPA, and the Trust have prioritized the remedial activities that need to be implemented to control future migration of impacts from the Site. The first set of prioritized actions includes the following:

- Enhancement and continuation of operating the Groundwater Containment System at the Site including land application of impacted water for a minimum period of 30 years;
- The use of land-use restrictions to control certain activities and uses of the Site;
• Post-Closure Care Monitoring of the CRS Unit; and
• Modification, operation, and maintenance of the Storm Water Management System.

The first three priorities are considered the primary remedial priorities which will be funded from the Remediation Trust. The fourth priority is considered a Site development priority which will be completed as part of the redevelopment of the Site by a future owner. However, if the Site does not sell or a redevelopment plan is not implemented within a reasonable amount of time (assumed to be within 5 years), the fourth priority may be completed and funded from the Administrative Trust.

KDHE, USEPA, and the Trust have also identified secondary priorities to assist in achieving the overall remediation goal for the Site. These secondary priorities will be addressed if funding remains after implementing the primary remedial priorities or as part of the financial assurance requirements for any prospective purchaser.

Therefore, the remedial action strategy of this RAP is prioritized to ensure adequate funding is available from the Remediation Trust to complete the three primary remedial priorities and, should Site development not occur within a five year timeframe, funding may be available from the Administrative Trust for completion of the fourth priority. While this strategy is limited in scope because of the funding limitations of the Trust, it is protective of human health and the environment and will allow for future commercial/industrial redevelopment of the Site.

The ultimate cleanup goal to allow unrestricted use of the property will not occur in the short-term because of the financial limitations of the Trust and the large areas needing active remediation. However, it is expected that through the implementation of the strategies presented in this RAP coupled with natural degradation processes, as well as future development activities, the Site will eventually be restored to a condition allowing unrestricted use.

This Remedial Action Plan (RAP) is intended to serve as a comprehensive summary of all investigation and remedial actions previously completed, currently underway, and proposed for future implementation at the Site.

Site history and past site characterization activities are presented in Sections 2 and 3. Discussion and justification of remediation objectives and goals are presented in Section 4. Sections 5 and 6 provide discussions of those areas of the Site that have been remediated, closed, or otherwise previously addressed.

Section 7 presents proposed actions for those areas of the Site that require remedial measures to mitigate future impacts to the environment and human health. Section 7 also includes an evaluation of remedial alternatives, along with a discussion of advantages and disadvantages and a cost estimate for each. The cost estimates are intended to provide a relative cost for each remedial option to assist in the decision-making process. Before implementation of a selected option, a detailed cost estimate for implementation will be prepared and will include a competitive bid process for required subcontracted services.

Section 8 provides a compilation of the preferred remedial alternatives, as presented in Section 7, and provides a summary of past and estimated future costs projections. The comprehensive strategy and phased schedule for implementation is also presented in Section 8.
2.0 Site Background

2.1 SITE DESCRIPTION

The former Farmland Industries Nitrogen Plant (Site) area encompasses approximately 467 acres, and is bounded on the north by 15th Street and the Burlington Northern Santa Fe Railroad. The remaining Site property lines border undeveloped and developed commercial property on the east, mixed industrial and residential areas on the west, and State Highway K-10 on the south. The Site has been inactive since its closure in 2001. Section 2.1 provides background information on site features that are essential to following the remainder of the remedial action plan. Section 2.2 provides additional detail on the operational history of the Site.

2.1.1 Site Location

The approximately 467-acre Site is located in Douglas County just outside the city limits of the City of Lawrence, Kansas, and approximately one-half mile south of the Kansas River. The 467-acre size includes approximately 30 acres of farm ground located north of the railroad tracks and south of 15th Street. The address of the Site is 1608 North 1400 Road Lawrence, Kansas 66046. The Site extends into Sections 4 and 5 of Township 13 South, Range 20 East (Figure 2-1).

2.1.2 Physiographic Province and Topography

The Site lies near the boundary of the Dissected Till Plain and the Osage Plain sections of the Central Lowlands physiographic province. The major topographic features near the Site are the east-trending Kansas River Valley and a series of north-south oriented upland cuestas formed by differential erosion of the bedrock (KGS, 1960). Surface water drainage from the plant is toward the Kansas River. Relief at the Site is dominated by a sandstone bluff overlooking the Kansas River valley. The average elevation of the Kansas River valley is approximately 817 feet above mean sea level (MSL), while the top of the bluff within the Site rises to just over 900 feet above MSL.

2.1.3 Climate

The climate at the Site is termed humid continental. In the Lawrence, Kansas area, annual extreme temperatures range from below zero to over 100°F. The average daily maximum temperature is 66.9°F and the average daily minimum temperature is 45.2°F, with a mean of 56.5°F (KGS, 1960).

Normal rainfall for the Lawrence area is 39.78 inches per year. Since 1999, annual rainfall totals have consistently been below normal on an annual basis (KSU, 2005). The prevailing wind direction is southerly, but in January and February northerly winds are more frequent. Winds in March tend to be easterly (USDA, 1997).
2.1.4 Geology and Soil

Site Stratigraphy

Bedrock occurs in outcrop and at depths up to 56 feet below ground surface (bgs) at the Site. Outcropping bedrock at the Site consists of the Pennsylvanian-age Stranger Formation of the Douglas Group. Deeper bedrock layers encountered in wells and borings at the Site include the Weston Shale and members of the Stanton Limestone. Figure 2-2 is a geologic map of the Site area as described on the geologic map of Douglas County (O’Connor, 1992).

The immediate Site area is characterized by a sandstone bluff overlooking the valley of the Kansas River. The sandstone exposed in the hill is the Tonganoxie Sandstone member of the Stranger Formation. The uppermost exposed beds at the Site are thin-bedded shaly sandstone probably equivalent to the Tonganoxie Sandstone. No massive sandstone was observed within the Site boundaries, but an outcrop was noted immediately west of the Site along 15th Street. The sandstone exposed on the Site is typically thin bedded with interbeds of sandy shale.

One or two borings have encountered a lenticular limestone beneath sandstone beds that is likely the Westphalia Limestone member of the Stranger Formation. A blue shale unit that is not exposed but is encountered in several deep borings on the Site is found below the Tonganoxie Sandstone. This shale is likely the Weston Shale. The uppermost rock unit present at the Site is the Vinland Shale member of the Stranger Formation and the deepest rock unit encountered in Site well borings is believed to be the Eudora Shale member of the Stanton Limestone.

The Pleistocene Kansas River Alluvium comprises the primary aquifer of the region. The alluvium is a thick valley fill consisting of unconsolidated sands and silts with minor clay. Coarse gravel is often present at the base. The Pleistocene Newman terrace was deposited on the valley flanks and is present on the Site as a relatively flat area slightly above the present alluvial valley floor and directly below the Sandstone Hill.

Two geologic cross sections were developed for the Site (see Figure 2-3A). Cross Section A-A’ (Figure 2-3B) begins at the southwest corner of the Site (Well MW-11) and trends northeastward to well PSW-09B. The clay to silty clay unit is present throughout the cross section. The sandy lower unit is present only in the northern part and pinches out onto the Sandstone Hill in the northwest portion of the Site. Bedrock lithologies include sandstone, shale, and limestone.

Cross section B-B’ (Figure 2-3C) begins near the western edge of the Site at well PSW-14 on the Sandstone Hill and runs northeastward through the Hill, then eastward through the northern ponds to well PSW-01B. The subsurface soil at the top of the bluff consists of silty clay or clay overlying primarily interbedded sandstone, siltstone, and shale bedrock. Fill material from 4 to 8 feet thick is found at the base of the bluff (Wells PSW-13A/B to PSW-17). A dark brown or black organic silty clay soil zone is present on the west side of the hill. Alluvial sands are present beneath the northern ponds at thicknesses of approximately 10 to 13 feet thick. Based on available information, the bedrock units (primarily interbedded sandstone and shale) in the Sandstone Hill are in direct contact with the alluvial aquifer.
Structural Geology

The Prairie Plains Monocline is the dominant regional structure that affects Pennsylvanian rocks in Douglas County. The Pennsylvanian rocks dip westward and northwestward at about 20 feet per mile (0.004 ft/ft). This structure is primarily post-Permian in age. Superimposed on the regional structure are many smaller synclinal and anticlinal structures. The amount of structural deformation generally increases appreciably with depth from the surface rocks into the older Pennsylvanian and Mississippian rocks. Faulting and sharp flexing occur in rocks of the Douglas and Pedee Groups and the Oread Limestone in southern Douglas County and adjacent areas to the south and west. No faulting is described in northeastern Douglas County (KGS, 1960).

Site Soils

Nine different soil mapping units, representing seven soil series, are present within the boundaries of the Site (Figure 2-4). These include: Kennebec silt loam, frequently flooded (7051); Pawnee clay loam, 3 to 6% slopes (7502); Pawnee clay loam, 3 to 6% slopes, eroded (7503); Sibleyville complex, 7 to 12% slopes (7602); Sibleyville loam, 3 to 7% slopes (7603); Vinland complex, 3 to 7% slopes (7651); Wabash silty clay loam, occasionally flooded (7090); Wabash silty clay, very rarely flooded (7280); and Woodson silt loam, 1 to 3% slopes (8962), (USDA, 2006). Miscellaneous water (9986) is also depicted on the soil map for the series of lagoons in the northern portion of the Site.

2.1.5 Site Hydrogeology

Surface Water Drainage

Storm water from the various areas of the site exits the Site through on-site ditches and ponds and is directed to the Kansas River. Storm water also drains into the Site from the south, including runoff from Highway 10 and from land south of Highway 10. Storm water that drains onto the Site, drainage from the South Process Area, and a large portion of undisturbed areas of the Site are all minimally impacted with nitrogen compounds. A map showing surface water flow directions, drainage areas, channels and piping, and surface water features is presented in Figure 2-5. Overall surface water runoff is generally to the north.

In addition to the surface water runoff being discharged from the site, groundwater extracted from three groundwater extraction wells is also being discharged to surface water. The three extraction wells are installed in the Kansas River alluvium and are being used to control off-site migration of nitrogen compounds in the deeper alluvial aquifer. The groundwater extracted from these wells contains low levels of nitrogen compounds (less than 10 mg/L).

On-site surface water features include several ponds, designated West Storm Water Pond, East Storm Water Pond, Central Storm Water Pond, East Lime Sludge Pond, West Lime Sludge Pond, Overflow Pond, Rundown Pond, East Effluent Pond, West Effluent Pond, West Pond, West Pond Extension, and Krehbiel Pond. Two ponds located behind the North End Maintenance Shop (Central Ponds) were removed in June 2006.

Storm water, sanitary sewer water from the plant, and the alluvial groundwater is discharged from a weir located north of the northwest corner of the Site on the south side of 15th Street.
Discharge from the weir flows north through a culvert under 15th Street and then flows approximately 2,000 feet in a discharge ditch to an unnamed tributary, which flows another 1,500 feet to the Kansas River.

No areas of the Site lie within the 100-year floodplain of the Kansas River, and only the Lime Sludge Landfill area near the eastern boundary of the Site lies within the 500-year floodplain (NFIP, 1981).

Hydrogeology

Two geologic cross sections were developed for the Site and are included as Figures 2-3B and 2-3C. Three hydrostratigraphic units have been identified on the Site: silty clay and overburden unit, consisting primarily of silty clays and clays (including fill and native soil); deep alluvial aquifer (Kansas River alluvium), consisting of sandy clays, sands, and gravel; and the bedrock unit, consisting of sandstone, limestone, and shale. The silty clay and overburden units are essentially the same unit, being distinguished only by their location. The silty clay unit refers to shallow saturated soils in the area of the process ponds and north into the Kansas River floodplain. The overburden unit refers to discontinuous areas of saturated sediments overlying bedrock at some locations on the Site.

Some previous reports have incorrectly referred to the bedrock unit as the “perched aquifer”. Other reports call the bedrock unit the “sandstone aquifer” even though water-bearing zones also include limestone and shale. The silty clay aquifer has also been referred to as the “perched aquifer” in some of the Farmland Performance Evaluation Reports. The silty clay and overburden units are presently believed to be unconfined. The alluvial aquifer may be semi-confined where it is overlain by the silty clay unit but is otherwise unconfined. The bedrock unit may be either confined or unconfined depending on the overlying unconsolidated material. Clay and shale aquitard units are present within the water-bearing units and are the source of surface seeps observed at the Site as described in previous reports.

The alluvial aquifer (Kansas River alluvium) is present in the area north of the northeast ponds and along the north side of the Sandstone Hill. It increases in thickness northward into the Kansas River floodplain. Groundwater flow in the alluvial aquifer is generally toward the northeast.

The bedrock unit underlies the unconsolidated aquifers. Overburden thickness ranges from 0 feet in several locations to more than 60 feet at the north end of the Site (Figure 2-6). The uppermost rock unit appears to be the Vinland Shale member of the Stranger Formation, and wells have penetrated as deep as what is believed to be the Eudora Shale member of the Stanton Limestone.

Hydrologic conditions at the site are influenced along the northern boundary by three active pumping wells and several shallow groundwater interception trenches. The pumping wells extract water from the alluvial aquifer and discharge water to the surface through the Effluent Pond. The interception trenches collect water from the shallow silty clay unit and currently discharge water to storage for later land application. The purpose of the groundwater extraction systems is to reduce off-site migration of nitrogen-impacted groundwater and to maintain hydraulic control of the proximal portions of the alluvial aquifer. This system has been successful in controlling/limiting off-site movement of nitrogen-impacted groundwater.
2.2 OPERATIONAL HISTORY AND CHRONOLOGY

2.2.1 Facility Operations

The former Farmland Industries Nitrogen Plant began operations in 1954 as the Cooperative Farm Chemical Association. Through the years the plant had been expanded and updated to provide a variety of nitrogen fertilizer products to local cooperatives in the Midwest. The plant was acquired by Farmland Industries in 1984. Products produced at this facility have included anhydrous ammonia, nitric acid, granular urea, prilled ammonium nitrate, and UAN solution. Each of these production areas consisted of a wide variety of structures and buildings. In addition to the production areas, the facility had diverse support activities which were located across the plant grounds. Figure 2-7 provides an aerial view of the Site.

Ammonia Plant

The original ammonia plant, referred to as the "Old Ammonia Plant", operated from 1954 to 1971. The Old Ammonia Plant was located in the southwest corner of the Site and adjacent to Highway K-10, as shown in Figure 2-7.

On the average, the Old Ammonia Plant produced 218,000 tons of ammonia per year. The Old Ammonia Plant was taken out of service when it was considered obsolete. From 1971 to 1981 the Old Ammonia Plant was dismantled. Process equipment was re-used on the Site, relocated to other Farmland facilities, or sold as scrap metal.

Construction on a New Ammonia Plant was initiated and completed in 1971. The New Ammonia Plant was located in the southwest portion of the Site between the No. 2 Urea Plant and the main Cooling Tower Area. Ammonia production was accomplished using natural gas, water, and air as the feedstocks. The production process involved steam-reforming of natural gas using the following steps: desulfurization, primary and secondary reforming, shift conversion, carbon dioxide removal, synthesis gas purification, and ammonia synthesis and recovery. Several catalysts are utilized in the ammonia production process. Many of the waste catalysts were sold for reclamation of metal content, and some were landfilled on-site.

Ammonia was produced until operations ceased in 2001. The New Ammonia Plant was auctioned and sold in 2004 to Oman Chemical and Pharmaceuticals LLC. Since that time, the New Ammonia Plant has been dismantled and shipped overseas.

Nitric Acid Plant

Nitric acid was produced for use as an intermediate in the manufacture of ammonium nitrate. The nitric acid production process involved the following steps: oxidation of ammonia to nitric oxide, oxidation of nitric oxide to nitrogen dioxide, and absorption of nitrogen oxides in water to produce nitric acid. Ammonia was oxidized to nitric acid by mixing with compressed air in the presence of a catalyst at high temperature. Cooling of the process stream converts nitric oxide to nitrogen dioxide, which is then introduced to a stream of water in an absorption tower, producing nitric acid.

The Nitric Acid Production Area is located in the southwestern portion of the Site and east of the cooling tower area (Figure 2-7). Six separate nitric acid production areas were located at the
Site. Plants No. 1 and No. 2 began operation in 1954 and were shut down before 1990. Plants No. 3 and No. 4 were constructed in 1958 and 1960 respectively, and were shutdown in the early 1990s. Plants No. 5 and No. 6 were constructed in 1963 and 1968 respectively, and were operational up to 2001. On average 275,000 tons of nitric acid were produced each year.

**Ammonium Nitrate Plant**

Two ammonium nitrate plants were operated at the Site. Plant No. 1 began operations in 1954 and produced approximately 217,000 tons of ammonium nitrate per year. Plant No. 2 also began operations in 1954 but was shut down in 1978. Both plants were located in the north central portion of the Site (Figure 2-7). The ammonium nitrate production process involved combining anhydrous ammonia and nitric acid solutions in a neutralizer. The heat from the reaction boiled away most of the water to form a concentrated liquid, which was sprayed downward through a tower to form solid spheres (prills).

**Urea Plant**

Urea production commenced at the Site in 1974 with approximate production of 170,000 tons per year. Urea was produced from anhydrous ammonia and gaseous carbon dioxide, both of which were obtained from the synthesis of ammonia. Both reactants were pumped into a high temperature, high pressure reactor to form ammonium carbonate, which immediately dehydrated to form urea and water. The urea and water stream was evaporated and was used to produce solutions or granular urea. Liquid urea solution was pumped to the North Production Area for use in urea ammonium nitrate (UAN) production.

The #2 Urea Plant was located in the southwest portion of the Site north of the New Ammonia Plant (Figure 2-7). Process waters resulting from the production of urea contained high concentrations of urea and ammonia. These waters were pumped to the Rundown Pond for reuse in UAN production. The #2 Urea Plant was auctioned and sold in 2004 to Oman Chemical and Pharmaceuticals LLC. Dismantling and shipment of the #2 Urea Plant was completed in January 2009.

**Urea Ammonium Nitrate (UAN) Area**

The UAN area is located in the north central portion of the Site, north of the Ammonium Nitrate Plants (Figure 2-7). UAN was produced by blending ammonium nitrate solution with urea solution. UAN production started in approximately 1959, producing 650,000 tons of UAN each year. Production ended in 2001 with the cessation of manufacturing operations.

**Facility Landfills**

During its operational life, the facility operated several landfills at the Site. The landfills were each established for disposal of specific waste streams active at the time. The following is a list of former landfills identified from available records, drawings, and institutional knowledge. Locations of the landfills are shown in Figure 2-8.

1. **Solid Waste Landfills** – Located in southeast quadrant of the property. Four open-trench disposal pits (“trash slits”) have been identified on facility drawings and are believed to have received typical non-hazardous office and cafeteria wastes. The newest of these landfills was closed under permit with KDHE.
2. Insulation Landfill – Located in southeast quadrant of the property. Known to have received foam glass insulation removed from the ammonia storage tanks. This landfill was closed under permit with KDHE.

3. Lime Sludge Landfill – Located at the east end of the north ponds. Known to have received sludge from the East Lime Pond. This landfill was closed under permit with KDHE.

4. Catalyst Landfill – Located north of the Urea Bulk Warehouse. Known to have received waste catalysts from plant operations that could not be sold for reclamation. This landfill was excavated and the contents disposed off-site in 2006.

5. "Original Landfill" – Located beneath #2 Urea Plant and area to the north. The purpose of this landfill and the disposed materials are not known. A summary of available information (provided to KDHE in March 2008) is contained in Appendix A.

One of the solid waste landfills, the Lime Sludge Landfill, and the insulation landfill were operated under permits issued by the State of Kansas. These landfills underwent permitted closure and were capped. Deed restrictions have been developed and recorded with Douglas County to prevent future disturbance of the buried wastes in these three landfills. Copies of the recorded documents are contained in Appendix B.

2.2.2 Facility Process Ponds

Krehbiel Pond

The Krehbiel Pond was constructed in the late 1970’s in its current configuration to contain storm water runoff from the north side of the Sandstone Hill. This pond collected water coming from the drainage of the west side of the Sandstone Hill that drained to the north. It also collected sheet flow drainage from the northeast side of the Sandstone Hill. This water was transferred to the West Pond by pumping.

This pond continues to be used in the same capacity. The water is being transferred to the effluent system during this interim period, but the capability to transfer to the West Pond still exists.

West Pond

The West Pond was constructed to contain and transfer storm water runoff and some process water discharge from the ammonium nitrate/UAN production plant at the north end of the Site. The water was directed by gravity flow from the West Pond to the West Extension Pond. This pond was constructed in this configuration in about 1975.

The configuration of this pond was changed in 2007 when a collection sump was installed where the water enters the pond. This collection sump allows the low flow water to be collected and transferred to storage tanks for later land application for beneficial use. The overflow water during rain events is transferred by pipes to the Krehbiel Pond for transfer to the effluent system.
West Extension Pond

The West Extension Pond was constructed as a small holding pond and transfer pond for the water collected in the West Pond and the Krehbiel Pond. This water was pumped to the Rundown Pond through stainless steel and HDPE lines for recycling and nitrogen recovery.

The current configuration of this pond has not changed however it only receives small amounts of water from the West Pond, direct precipitation and some rail line drains. The water collected in this pond is transferred to the effluent system for discharge from the Site.

West Effluent Pond and East Effluent Pond

The West Effluent Pond is the original effluent pond constructed in approximately 1953. This pond received all process wastewater and storm water runoff from the south end of the facility from 1953 until the East Effluent Pond was constructed in the early 1970’s. In about 1974, the West Effluent Pond and East Effluent Pond were constructed in the basic current configuration.

Since about 1974, both ponds have received process wastewater and storm water runoff from the south end of the Site. This process wastewater consisted of boiler blowdown, cooling tower blowdown and process water wastes from the ammonia plant, nitric acid plants, boiler house and chromium reduction system. It also contained storm water runoff from the south end of the Site. The water entering these ponds was discharged to the Kansas River. Starting in about 1974, the discharge was regulated by National Pollutant Discharge Elimination System (NPDES) permits issued by KDHE.

These ponds currently receive storm water runoff from the south end of the Site, transferred and diverted storm water runoff from the north end of the Site, and the sanitary sewer discharge. These waters are discharged off site through the current NPDES permit.

West Lime Sludge Pond

The West Lime Sludge Pond was constructed prior to 1960. The purpose of the pond was to receive lime sludge from the lime softening water treatment system. This pond continued to be used in this state until about 1995. Intermittently during this operational period, sludges from other ponds were transferred to this pond for storage. By about 1995 this pond was filled and use was discontinued. Currently this pond is not being used.

Rundown Pond

The Rundown Pond was constructed in the early to mid 1970’s with the purpose of providing a holding pond for nitrogen impacted storm water and process water from the north facilities at the Site. This pond received storm and process waters, both from direct flow and pumped water. The water in this pond was recirculated back to the plants where the water was evaporated off and the nitrogen compounds concentrated. This concentrated solution was then blended into the products. This Pond continued in this operational mode until the production facilities were shut down in early 2001. The Pond continued to collect water until about 2007 when all the water was diverted to other ponds. Water collected in this pond since about 2002 has been land applied for beneficial use of the nitrogen compounds.

Currently, this Pond collects only precipitation that falls on it. Due to the amount of nitrogen in the sediments, this water is impacted and is land applied for beneficial use.
Overflow Pond

The Overflow Pond was constructed in the mid 1970’s to act as an overflow pond to the Rundown Pond. This pond received flow from the Rundown Pond when the level in the Rundown Pond was approaching maximum. This water was recovered in the same system as the Rundown Pond.

In 2007, it was determined that this pond would be the designated pond for collection of nitrogen impacted storm water runoff from the north end of the Site. In preparation for this use, the sludges were cleaned from this pond and drainage piping for the north end storm water was extended to this pond. At this time, this pond is collecting some nitrogen impacted storm water runoff. It also collects the water pumped from the groundwater collection systems on the Site when the aboveground storage tanks are not available. The water collected is land applied for beneficial use of the nitrogen content.

East Lime Sludge Pond

The East Lime Sludge Pond was constructed in about 1995 to accept lime sludge from the cold lime softening of water. This pond was constructed to replace the West Lime Sludge Pond which was full. This pond continued in this capacity until production was shut down in 2001.

Most recently, this pond received some sludges removed from other small ponds on Site during the Interim Measures Activities.

2.2.3 Facility Water Management

When the Site was operational, water was used in all areas of the plant. Water was used in various ways in the different process plants. In the production of ammonia, it was used as steam in the steam reforming process. In the nitric acid plants, water was used to absorb the nitric oxides to form nitric acid. Water was also used in all the process plants for cooling.

Water was obtained from both wells and purchased from the City of Lawrence Water Department. The vast majority of water used in the process was obtained from wells owned by Farmland. The water was pumped to the Site and treated on site. All the water was treated by cold lime softening. For water that needed to be more highly purified hot lime softening and demineralization were used. Water was pumped into the Site from the well field at the rate of approximately 2000 gallons per minute. Some water was purchased from the City of Lawrence, usually during a time when excess water was needed above that which could be pumped from the well field.

The infrastructure for water treatment included cold lime softening units, hot lime softening units, demineralizers, storage tanks, pumps, and piping necessary to transport the water to where it was needed. The infrastructure also included the boilers needed to produce steam.

A significant portion of the water used on site was used as cooling water in the various processes. Cooling water was pumped through heat exchangers where it extracted heat from the process fluids, either gases or liquids. It continued back to the cooling towers where air was pulled through the falling water to cool the water. This resulted in some of the water being evaporated and the remaining water becoming more concentrated with the dissolved chemicals in the water. As the cooling water became more concentrated, it was necessary to remove or
“blow down” part of the water and replace it with fresh water. The “blow down” was discharged to the internal sewer system or effluent that was eventually discharged to the Kansas River through an NPDES permit.

At times, the heat exchangers would develop leaks and process fluids would pass into the cooling water as it flowed through the heat exchangers. In the cases where the process stream being cooled contained nitrogen compounds, such as ammonia, urea or ammonium nitrate, the cooling water became impacted with the nitrogen compounds. This resulted in the effluent system being impacted with nitrogen compounds. Since the NPDES permit had limits to the amount of nitrogen that could be discharged, these leaks would require that the heat exchanger or plant be shut down and the leak fixed.

There were, at times, leaks of process fluids to the environment. Depending on the process area, leaks that impacted the ground surface were managed in different systems. In the ammonia area at the south end of the Site, leaks were not contained in the overall plant. These leaks, if in a liquid state would eventually be carried to the NPDES effluent system for discharge. In the Nitric Acid Area of the plant, there was a leak collection system that was installed to collect leaks from certain vessels that contained nitric acid. These leak collection systems were returned to the product tanks. Outside these leak collection systems, the leaks would enter the NPDES effluent system.

In the #2 Urea Plant, the entire production area was curbed so that no leaks or storm water could leave the process area and enter the NPDES effluent system. This curbed area drained to a large tank, which included process and product leaks or spills, and was pumped to the north end of the site where the solution was placed into the collection system for recovery of the nitrogen.

The major underground piping on the Site has been identified and is shown on Figures 6-3 and 6-4.

Since 1972, the Site has discharged waste water to the Kansas River under the authority of an NPDES permit issued by KDHE. The permit has periodically been revised and reissued with more restrictive limits on the amount of ammonia and nitrate that could be discharged. A new permit was approved by KDHE in January 2005 with the permit limits based on federal effluent guidelines and surface water quality standards. The permit allows for a daily average of 247 pounds nitrate-nitrogen to be discharged. The permit also allows an ammonia-nitrogen daily average concentration of 50 mg/L and a daily average of 530 pounds.

Since the shutdown of the production facilities, no process water has been discharged; however, storm runoff water is still passed through the effluent system and discharged to the river in accordance and in compliance with the current NPDES permit. The current permit is based on surface water quality standards and best professional judgment. The ultimate goal of the RAP following remediation with respect to storm water discharge is that runoff leaving the site is roughly of the same quality as storm water entering the site.

Confirmation sampling is periodically completed to monitor surface water chemical composition with respect to NPDES permit requirements.

Because of the ever-increasing limitations of the NPDES permits, during its years of operation the Site utilized water pollution control systems to reduce the amount of ammonia and nitrates that
were discharged to the NPDES-permitted outfall. Process waste streams and storm water runoff from the Urea Production Area and Ammonium Nitrate Area were collected in a series of lagoons/ponds located in the northern portion of the Site. This water was then concentrated in the nitrate area concentrator or ammonia plant area concentrator and pumped to the concentrate storage pond for use in UAN solutions blending. The concentrate storage ponds were removed in 1988. There is no documentation concerning the removal and disposal of materials in the concentrate storage ponds. In the early 1990's a 6-million-gallon capacity aboveground storage tank (AST) was constructed on the site of the former concentrate storage ponds.

When operations ceased in 2001, the nitrate-impacted storm water runoff could no longer be returned to the plant process and nitrate-impacted runoff was subsequently directed to and stored in the Rundown and Overflow Ponds located in the northeastern portion of the Site.

A water management plan was submitted to KDHE on March 10, 2005, in support of a land application proposal. The land application proposal was approved and received from KDHE on April 22, 2005. This water management plan outlines the steps that the FI Kansas Remediation Trust will take to beneficially use the water contained in the ponds and collected in the French drain (trench) system for agricultural purposes. Land application activities began in the fall of 2005. The 6-million-gallon AST, as well as a 2-million-gallon capacity AST, are used to hold the water from the Rundown Pond before being pumped out to agricultural fields located north of the Site.

Cooling tower blowdown water produced during the operational years of the Site was discharged to the effluent pond system also located in the northeastern portion of the Site. The cooling tower blowdown water would have contained hexavalent and trivalent chromium prior to 1984.

The series of ponds, primarily the Rundown and Overflow Ponds, located in the northeastern portion of the Site represent the primary site concern as a nitrate source area. Previously, surface water runoff from the areas of the Site known to have nitrate-impacted soils was routed to the Rundown and Overflow Ponds. In the winter of 2004 water handling practices were revised, as approved by the KDHE, to minimize the amount of water directed to these ponds. Engineering controls have been put in place to re-direct clean surface water runoff to the Effluent Pond System. In 2006, additional modifications were made so that all surface water runoff that meets NPDES discharge limits is directed to the Effluent Pond System and discharged. Currently, no water is being directed to the Rundown Pond.

### 2.2.4 Previous Investigations

The Site has undergone several episodes of environmental investigation since the 1970’s. This section contains a synopsis of the investigative activities. More detailed discussions of each phase are provided in Section 3.2.

Previous investigations of the Site have included studies by Woodward-Clyde Consultants (WCC) beginning in 1974. The WCC studies focused on characterizing groundwater quality at the northern boundary of the Site. This investigation resulted in the construction of two interceptor trenches to capture shallow groundwater migrating off the Sandstone Hill in the northwest portion of the Site. In November of 1985, WCC completed the Revised Alternate Groundwater Monitoring Plan.
Geraghty & Miller completed a RCRA Surface Impoundment Closure Certification Report in support of closure of the chromium reduction system (CRS) unit on January 14, 1987. A RCRA Facility Assessment (RFA) was completed by PRC Environmental Management in September 1990. The RFA listed 21 solid waste management units (SWMUs) as areas requiring further investigation and 4 Areas of Concern (AOCs). Farmland and KDHE entered into a Consent Agreement (Consent Order Case No. 92-E-27) on January 27, 1993 to conduct a Comprehensive Investigation/Corrective Action Study (CI/CAS). This investigation was completed by Environmental & Safety Services Inc., with submittal of their CI report characterizing the 21 SWMUs and identified areas of concern (AOCs) in January 1994. A supplemental report was completed in October 4, 1994. The CI investigations also included a groundwater investigation that identified three water-bearing zones impacted by nitrates. The CAS report was completed and approved on April 12, 1995. In 1997, a Corrective Action Plan (CAP) was created by Farmland Industries to install a French Drain system and recovery wells in the area of the ponds in northern part of the Site. KDHE approved the CAS and CAP based on the assumption that the plant would continue to operate and the recycle/reuse assumptions for recovered contaminated groundwater would continue to be valid. After termination of plant operations in 2001, the recycle/reuse assumptions were no longer applicable, and KDHE requested that the Trust perform additional investigation and develop a modified remedy.

In accordance with the Schedule of Compliance in Kansas Permit I-KS31-PO04 issued in January 2000, Farmland conducted an engineering study of the storm water and wastewater pond system at the Lawrence facility. The report was delivered to KDHE in December 2001. The study consisted of monitoring storm water runoff from the facility to determine any potential changes to the storm water management system. This storm water monitoring program and system has been continued and modified for the site. The program has been modified to monitor sources of nitrogen emanating from the north end of the site with the purpose of determining major and minor sources that are directly affecting storm water runoff.

A full Site Characterization was conducted by Shaw in 2005 with the Site Characterization Report (SCR) completed in February 2006. The SCR presented environmental data to identify the lateral and vertical extent of the targeted analytes at the Site identified in the 1990 RFA report. The SCR reorganized the Site’s twenty-one SWMUs and four AOCs designated by the RFA into six remedial management areas (see Section 3.1).

An Interim Measures Plan was approved in April 2006 to mitigate portions of the environmentally-impacted areas at the Site. These areas included the Central Ponds, West Pond, Krehbiel Pond, the Oil Pond, the Spill Pond, and the Catalyst Landfill. The nitrogen-impacted soils from the Central Ponds, Krehbiel Pond, and West Pond were excavated and the material was placed in the on-site East Lime Pond, which had been previously dewatered. Soils from the Catalyst Landfill were disposed off site as special waste. The Oil Pond and Spill Pond were covered with topsoil graded to prevent ponding during precipitation events, and seeded with native grasses. Interim measure activities were completed from May 15, 2006 through June 14, 2006. In April 2005, as part of the approved interim measures, KDHE authorized application of nitrate-impacted water from the Rundown Pond and Overflow Pond on to agricultural fields north of the Site.

A Revised Drainage Study was conducted in August 2007 to examine storm water drainage and surface water runoff at the Site. A Geological Characterization of the Sandstone Hill was also
conducted in August 2007. A supplemental soil investigation was completed in September and October 2007 in selected production areas and beneath former cooling towers following the demolition and removal of the cooling tower structures.

In compliance with the 1997 CAP, Farmland and the Trust have been conducting quarterly groundwater monitoring activities and summarizing the nitrate and ammonia recovery systems in Performance Evaluation Reports since 1998. As of December 31, 2008, 42 quarterly performance evaluation reports have been submitted to KDHE.

In October of 2008, KDHE completed a Site walk-through and a limited investigation of groundwater and soil in certain areas to further characterize several data gaps that were identified during review of the first draft of the RAP.
3.0 SITE CHARACTERIZATION SUMMARY

Characterization of the Site has been accomplished in several independent phases beginning with a soil investigation in 1974. The data objectives have varied among the assorted phases of work, and the results of one investigation do not always supplement subsequent phases. Text in this section provides a synopsis of work performed and conclusions drawn. Complete text, tables, and figures of the reports referenced in this section are provided for review on the compact disk (CD) contained in Appendix C.

3.1 REMEDIAL MANAGEMENT UNITS

In support of the 2006 Site Characterization Report objectives, the Site was divided into seven remedial management units based on former use and/or natural boundaries. These units are as follows and as further described below:

- Area A: UAN Storage Area (Sandstone Hill)
- Area B: Northern Ponds
- Area C: Northwest Site Area
- Area D: Operations Area
- Area E: Southwest Site Area
- Area F: Southeast Site Area
- Off-Site Groundwater

The boundaries of the management areas are shown in Figure 3-1.

Area A: UAN Storage Area (Sandstone Hill)

Area A is comprised of what formerly had been designated as the UAN Storage and Concentrate Ponds Area (Sandstone Hill), Ammonium Nitrate Processing Area, Nitrate Bulk Warehouse, and included the UAN and the ammonium nitrate plants and associated support structures and buildings. This area comprises approximately 78 acres and lies in the north central area of the Site. This area is topographically the highest area of the Site and includes the Sandstone Hill.

Area B: Northern Ponds

Area B is comprised of a series of ponds located in the far northeastern area of the Site. These ponds, in order from west to east, are Krehbiel Pond, West Pond, West Extension Pond, West Effluent Pond, East Effluent Pond, West Lime Pond, Rundown Pond, Overflow Pond, and East Lime Pond. This total area covers approximately 66 acres. The six primary ponds (West Effluent Pond, East Effluent Pond, West Lime Pond, Rundown Pond, Overflow Pond, and the East Lime Pond) were designed to receive different process waters and storm water runoff. The approximate design dimensions of these ponds as obtained from historical as-built drawings are included in the following table:
Northern Pond Dimensions

<table>
<thead>
<tr>
<th>Pond Name</th>
<th>Length</th>
<th>Width</th>
<th>Designed Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Effluent Pond</td>
<td>1,250 feet</td>
<td>380 feet</td>
<td>8 feet</td>
</tr>
<tr>
<td>East Effluent Pond</td>
<td>1,025 feet</td>
<td>195 feet</td>
<td>10 feet</td>
</tr>
<tr>
<td>West Lime Pond</td>
<td>850 feet</td>
<td>212 feet</td>
<td>10 feet</td>
</tr>
<tr>
<td>Rundown Pond</td>
<td>950 feet</td>
<td>420 feet</td>
<td>17 feet</td>
</tr>
<tr>
<td>Overflow Pond</td>
<td>600 feet</td>
<td>350 feet</td>
<td>14.5 feet</td>
</tr>
<tr>
<td>East Lime Pond</td>
<td>550 feet</td>
<td>250 feet</td>
<td>10 feet</td>
</tr>
<tr>
<td>West Extension Pond (triangular pond)</td>
<td>510 feet x 450 feet x 225 feet</td>
<td>NA</td>
<td>10 feet</td>
</tr>
<tr>
<td>Krehbiel Pond</td>
<td>450 feet</td>
<td>75 feet</td>
<td>Unknown</td>
</tr>
<tr>
<td>West Pond</td>
<td>300 feet</td>
<td>75 feet</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Area C: Northwest Site Area

Area C is located in the northwestern portion of the Site and is comprised of approximately 77 acres of grass and wooded land. This area includes the area referred to as the Central Storm Water Pond Watershed. This area had not been used in the past for Site operations, with the exception of the Catalyst Landfill on the southern edge.

Area D: Operations Area

Area D is located in the south central area of the Site and borders the north side of Highway K-10. This area covers approximately 56 acres and was the site of main plant operations. This area is comprised of eleven sub-areas that have been designated as:

- Oil Pond: The Oil Pond was used for fire control training, with waste oil used as the ignitable medium.
- Spill Pond: The Spill Pond was constructed to contain potential spills from the unloading of #6 fuel oil which was used as a backup fuel source.
- Urea Area: Urea was produced in this area, generating process waters high in concentrations of urea and ammonia. These process waters were formerly pumped to the Rundown Pond for re-use.
- Chrome Reduction Area (CRS Unit): Although included in this report as an area of concern, the CRS Unit has been characterized during a RCRA closure process and is currently in post-closure monitoring. The Kansas Bureau of Waste Management approved the first phase of a work plan in September, 2005 to expedite the remediation of low pH in this area.
• Paint Shop Maintenance Area: This consists of the Paint Shop, Garage, and Gravel Lot. This area was used for the storage and use of paints and solvents, as well as the storage of used oil.

• Ammonia Production - Primary Reformer Area: This area was used for the production of ammonia and also includes the primary reformer that was used to incinerate used oil. The primary reformer was sold and removed.

• Cooling Towers: Several cooling towers are located on the facility property with the majority of the cooling towers located in this area.

• Nitric Acid Area: Nitric acid produced in this area was used in the production of ammonium nitrite.

• Boiler Furnace and Fuel Oil Storage: The Boiler Furnace primarily used natural gas. It also used #6 fuel oil as a backup fuel source. The fuel oil was stored in aboveground tanks located just south of the furnaces.

• Old Ammonia Plant: The Old Ammonia Plant was taken out of service in 1971 and dismantled. This plant utilized large diesel compressors that contained lubricant oil as well as using diesel as a fuel source.

Area D also included the ammonia plants, six nitric acid plants, the urea plants, the cooling towers, and the associated support structures and buildings including the administration building and the on-site laboratory.

Area E: Southwest Site Area
The Southwest Site Area consists of approximately 55 acres that border the western boundary of the Site and extends south of the administration building and adjacent to the north of Highway K-10. This area of the Site is vegetated with native grasses and has not been used for primary Site operations.

Area F: Southeastern Site Area
The Southeastern Site Area is undeveloped natural terrain that contains primarily grasslands, shrubs and natural drainage features. This approximately 91-acre area was not utilized directly in production operations. This area is bordered to the south by Highway K-10 and to the east by an industrial park. The western boundary of Area F follows the main drainage ditch in its northwestern corner and the railroad tracks in the west-central section. This west-central border between Area F and Area C is modified slightly from the border depicted in the 2006 Site Characterization Report for the purposes of delineating remedial action areas later in this report.

The Areas A through F described in this Section will be used for reference throughout the remainder of this document.

Off-Site Groundwater
One area of interest not contained within the Site boundaries is the impact to off-site groundwater. The Site is bounded on the north by the floodplain of the Kansas River. The alluvial aquifer beneath the floodplain is an economically important source of water for the region and provides base flow to the river itself. Groundwater flow from the Site is currently intercepted
by a groundwater pumping system which diminishes the risk of impact to the alluvial aquifer. The off-site groundwater area of interest is bounded on the south by the Site property line and on the north by the Kansas River.

3.2 SUMMARY OF INVESTIGATIONS

A roster of major site characterization or investigation documents and reports prepared for the Site is provided in the following table. Further discussion of each is presented in this section.

<table>
<thead>
<tr>
<th>DATE</th>
<th>TITLE / REFERENCE</th>
<th>SOURCE / AUTHOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/13/1974</td>
<td>Soil Investigation of Seepage from Holding Ponds</td>
<td>Woodward-McMaster</td>
</tr>
<tr>
<td>3/19/1975</td>
<td>Groundwater Contamination Study - Phase II</td>
<td>Woodward-Clyde</td>
</tr>
<tr>
<td>6/10/1975</td>
<td>Subsurface Investigation/Underdrain Constr. &amp; Pond Lining</td>
<td>Woodward-Clyde</td>
</tr>
<tr>
<td>6/17/1975</td>
<td>Underground Water Study - Phase III</td>
<td>Woodward-Clyde</td>
</tr>
<tr>
<td>1/14/1987</td>
<td>RCRA Surface Impoundment Closure Certification Report</td>
<td>Geraghty &amp; Miller</td>
</tr>
<tr>
<td>8/15/1994</td>
<td>Supplemental CI Report</td>
<td>ESSI</td>
</tr>
<tr>
<td>11/17/2005</td>
<td>CRS pH Study Report</td>
<td>Shaw</td>
</tr>
<tr>
<td>2/1/2006</td>
<td>Site Characterization Report</td>
<td>Shaw</td>
</tr>
<tr>
<td>5/9/2006</td>
<td>Supplemental Groundwater Site Characterization Report</td>
<td>Shaw</td>
</tr>
<tr>
<td>7/20/2007</td>
<td>Geologic Characterization of Sandstone Hill</td>
<td>Shaw</td>
</tr>
<tr>
<td>10/25/2007</td>
<td>Supplemental Soil Investigation Report</td>
<td>Shaw</td>
</tr>
<tr>
<td>10/27/2008</td>
<td>KDHE Data Gap Investigation Report</td>
<td>KDHE</td>
</tr>
</tbody>
</table>

In addition to these reports, groundwater monitoring and containment system performance data has been documented in quarterly Performance Evaluation Reports submitted to KDHE beginning March 1998. Also, data related to monitoring and cleanup of groundwater in the CRS unit have been reported to KDHE on an annual basis since the Post-Closure Care and Monitoring Permit was issued in 1993. Copies of the most recent versions of these reports are provided on the CD in Appendix C.

The following section provides a brief discussion of the various site characterization phases and results as they pertain to each remedial management area, as defined in Section 3.1.
3.2.1 Soil Investigation of Seepage from Holding Ponds

This investigation, performed by Woodward-McMaster & Associates in November 1974, is the earliest documented environmental investigation performed at the Site. The purpose of the investigation was to determine if the impacted effluent from the retention ponds at the north end of the facility (Area B ponds) had seeped into the underlying aquifer. Test pits were dug along the northern dikes of the ponds. In addition, one boring and four observation wells were drilled. Soil samples were collected from the test pits and borings, and groundwater was collected from the installed monitoring wells. Six pre-existing “Sample Wells” were also present at the time of this investigation, although no history for these wells is provided.

Based on the results obtained from this investigation, the following was determined:

- The contents of the retention ponds had seeped into the underlying clays.
- The alluvial aquifer north of the Site was impacted by ammonia and nitrate.
- The degree of impact increased from east to west along the north boundary of the Site.
- Further study of groundwater impacts and flow direction were needed in order to develop an appropriate method for containment.

This phase of investigation related only to Area B soil and groundwater and off-site groundwater impacts. A copy of this report is provided on the CD in Appendix C.

3.2.2 Groundwater Contamination Study

This investigation, performed by Woodward-Clyde Consultants between January and March 1975, was a continuation of the 1974 investigation of the holding ponds and areas down-gradient. Thirty-three additional borings were drilled along the drainage channel north of the Site and in suspect areas in the northern portions of the Site. The investigation identified the distinction between the shallow groundwater system in silty clays and the deeper alluvial sand groundwater system. In addition, the Sandstone Hill hydrogeologic regime was identified and investigated.

The report concluded that seepage of discharge water from the effluent channel north of the Site was impacting the alluvial aquifer. In addition, groundwater in the Sandstone Hill was impacted by ponds formerly located on the hill and that seepage of groundwater from the Sandstone Hill was a source of contaminants in the alluvial aquifer. Seepage of water from existing ponds into shallow clay deposits was also a source of contaminants to the alluvial aquifer.

This phase of investigation related to soil and groundwater in Area A and Area B and off-site groundwater impacts. A copy of this report is provided on the CD in Appendix C.

3.2.3 Groundwater Study/Underdrain Construction & Pond Lining

Based on soil seepage and groundwater contamination studies described above, the determination was made that shallow groundwater collection should be accomplished in the area of the “old” and “new” West Ponds, which stored concentrated plant effluent and seepage from the Sandstone Hill to the west. Neither of the ponds was lined with impermeable material to
inhibit infiltration of impacted water. The silty clay groundwater was determined to be a source of impacts to the deeper alluvial aquifer beneath the Kansas River floodplain.

Two documents by Woodward-Clyde Consultants, dated June 1975, summarize the groundwater study results and describe details of the recommended approach to mitigate environmental impacts. The reports recommended and described the construction of two groundwater interceptor drains. One drain was recommended for the bottom of the Sandstone Hill near the present Krehbiel Pond. The second drain was recommended for the area north of the present West and West Extension Ponds along the railroad tracks. The purpose of the drains was to prevent further migration of nitrate impacted groundwater from exiting the property toward the north.

This phase of investigation was related to groundwater in Area A and Area B and off-site groundwater impacts. A copy of this report is provided on the CD in Appendix C.

3.2.4 Report on Rainwater Runoff and Soils Testing

Two reports by John Currens dated June and September 1982 studied the degree and impact on surface water runoff caused by surface soils on the plant property. The study included the collection of storm water runoff during rain events and soil samples from various plant areas and drainage ditches in the northern parts of the Site.

Runoff samples indicated that the heaviest impact occurred in water exiting the Sandstone Hill north of the Concentrate Ponds on top of the hill and flowing to the west side of the Bag Warehouse. Impacted runoff was found on the hill northeast of the No. 2 Urea Plant and on the hill northeast of the north-end Maintenance Shop. The report recommended that runoff water from west of the Bag Warehouse be diverted to the Rundown Pond.

Surface soils samples were collected to determine whether or not the contamination was due to material in the soil or from direct impact by plant operation or air scrubbing or fallout. The sampling effort identified several areas around the Site with particularly high concentrations and discussed possible sources. The reports concluded that contamination of storm water runoff was due to nitrogen in the soil rather than direct impact by plant operations.

This phase of investigation related to surface water runoff and soil impacts in Area A, Area B, and Area C. A copy of this report is provided on the CD in Appendix C.

3.2.5 CRS Groundwater Quality Assessment Report

An assessment of the groundwater in the chromium reduction system (CRS) area was conducted in 1986 following the installation of monitoring wells in 1982 and 1983. The surface impoundment for removal of chromium from cooling tower waters was taken out of service in the autumn of 1984. Monthly groundwater sampling and analysis for chromium and pH was carried out on the wells from the time of their installation to the time of the assessment. In addition to contaminant chemical data, the assessment included the determination of groundwater physical flow characteristics, including hydraulic gradient, hydraulic conductivity, and flow rate. The assessment was confined to groundwater in the overburden and shallow bedrock above the Weston Shale, in which no chromium impact was found. The overburden and shallow bedrock was considered to be a single hydrogeologic unit.
The sources of chromium were identified as the drainage ditch located between the former sulfuric acid pond outlet pipe and the former sulfur dioxide outlet pipe and the chrome reduction impoundment. Chromium concentrations were found to be decreasing at the time of the assessment and ultimately decreased to non-detectable levels after this assessment was completed.

Movement of groundwater was determined to be toward the northeast at a rate between 22 and 30 feet per year. Hydrologic determinations of flow rate were found to be consistent with observations of chemical data collected over time.

Results of the assessment were presented in a report by WCC. This assessment pertains to surficial groundwater in the CRS unit within Area D. A copy of this report is provided on the CD in Appendix C.

### 3.2.6 RCRA Surface Impoundment Closure Certification Report

The CRS surface impoundment, consisting of a 360-foot long drainage ditch and 20- to 60-foot wide by 80-foot long pond, was taken out of service in 1984. The CRS had a design treatment capacity of 84,000 gallons per hour. A RCRA Closure Plan was submitted to KDHE in March 1986 and approved by KDHE in June 1986. The closure process included:

- Sampling and analysis of soil in the surface impoundment ditch and pond.
- Sampling and analysis of the pond liner (petromat) material.
- Removal of contaminated soils and liner with disposal at a hazardous waste facility.
- Construction of a shallow groundwater interceptor trench to accelerate removal of contaminated groundwater.

The impoundment was divided into eight sections for sampling purposes. A total of 30 composite soil samples and four petromat samples were collected and analyzed for total chromium concentrations. In addition, 12 of the samples were analyzed for EP toxicity. Analytical results did not identify chromium concentrations above the analytical method detection limits below a depth of 24 inches. All samples collected from the drainage ditch contained total chromium concentrations above the action level of 32 mg/kg. Three of the four sections in the pond contained total chromium above the action level at depth of up to 24 inches. EP toxicity results were all below analytical method detection limits.

The selected remedy for soils and petromat exceeding the action level was removal and disposal at a licensed hazardous waste disposal facility.

Soil removal operations are documented in the closure certification report. A total of 496 cubic yards of impacted soil was removed from the ditch and pond. Soils were transported to Peoria Disposal Company facility in Peoria, Illinois.

A French drain was installed in September 1986 to intercept the flow and accelerate the removal of shallow groundwater in the area. The drain was installed in the upper surface of unweathered sandstone. A sump was installed at the north end of the drain with a discharge pipe and valve direct discharge to the drainage ditch.
This phase of sampling and remediation is related to surficial groundwater and soil in the CRS unit within Area D. A copy of this report is provided on the CD in Appendix C.

3.2.7 RCRA Facility Assessment

The U.S. USEPA conducted a RCRA Facility Assessment (RFA), which included a preliminary review and visual inspection, of former nitrogen plant in May 1990. The purpose of the RFA was to evaluate existing information and collect further information to identify releases of hazardous waste, identify solid waste management units (SWMUs) and areas of concern (AOCs), determine the need for further action or interim measures, and screen from further investigation those SWMUs that do not pose a threat to human health or the environment.

Twenty-one SWMUs were identified at the Site. The following list also indicates the current Remedial Management Area in which they are located.

- SWMU No. 1 – CRS Surface Impoundment (Area D)
- SWMU No. 2 – Acid Pond (Area D)
- SWMU No. 3 – Caustic Pond (Area D)
- SWMU No. 4 – Sludge Pond (Area B)
- SWMU No. 5 – Catalyst Landfill (Area C)
- SWMU No. 6 – Lime Sludge Pond (Area B)
- SWMU No. 7 – Effluent Pond (Area B)
- SWMU No. 8 – Gravel Lot (Area D)
- SWMU No. 9 – Used Oil Tank (Area D)
- SWMU No. 10 – Spent Battery Storage Area (Area D)
- SWMU No. 11 – Boiler Furnace (Area D)
- SWMU No. 12 – Hazardous Waste Storage Area (Area D)
- SWMU No. 13 – Primary Reformer (Area D)
- SWMU No. 14 – Imhoff Tank (Area A)
- SWMU No. 15 – Sewage Plant Sludge Bed (Area A)
- SWMU No. 16 – Spill Pond (Area D)
- SWMU No. 17 – Oil Pond (Area D)
- SWMU No. 18 – Runoff Pond (Area B)
- SWMU No. 19 – Overflow Pond (Area B)
- SWMU No. 20 – Solid Waste Landfill (Area F)
- SWMU No. 21 – Drainage Ditch (Areas A and C)

In addition, four AOCs were identified:

- AOC No. 1 – Neutralize Condensate Pond (Area A)
- AOC No. 2 – Concentrate Storage Ponds (Area A)
- AOC No. 3 – All Cooling Towers (Area D and Area A)
- AOC No. 4 – SO₂ Building (Area D)
Eight of the SWMUs and one of the AOCs were identified as requiring no further action based on the nature of their construction, waste handling practices, and sampling results. Further discussion of these SWMUs and AOCs is provided in Section 5.

This phase of work related to site-wide soil, surface water, and groundwater impacts in all Areas of the site. A copy of this report is provided on the CD in Appendix C.

**3.2.8 Comprehensive Investigation Report and Supplement**

A comprehensive investigation (CI) was undertaken in 1993 to address the SWMUs and AOCs identified as requiring further action in the 1990 RFA report. The CI was performed to satisfy the requirements of the Consent Agreement entered into with KDHE (Consent Order No. 92-E-27). Nine SWMUs, one AOC, and the nitrate bulk warehouses were investigated. A total of 107 soil, sediment, and sludge samples were collected, and 99 groundwater, surface water, and oil samples were collected during the CI.

In conjunction with SWMU and AOC characterization, an overall evaluation of migration and control of nitrate contamination in groundwater at and near the facility was performed, including the use of mathematical groundwater modeling to evaluate the hydraulic control mechanisms necessary to control the off-site migration of contaminated groundwater.

Two corrective action alternatives were evaluated for groundwater impacts – hydraulic control with reuse and hydraulic control with discharge. The groundwater modeling effort indicated that by extending the existing drain system to the east, the off-site migration of contaminated groundwater in the upper zones of the groundwater system could be controlled. Off-site migration of groundwater in the lower zones of the aquifer could be controlled by installation of three pumping wells.

Supplemental sampling was conducted in summer 1994 to complete the characterization of several SWMUs sampled in the first phase of investigation (north ponds). Soil and sediment samples were taken and monitoring wells were installed around the ponds to characterize groundwater impacts. In addition, attempts were made to install monitoring wells on off-site private property north of the Site. Slug tests and pump tests were conducted to quantify hydraulic characteristics of the groundwater systems and to support the design and operational parameters of the groundwater containment system.

The Revised Draft CI Report was issued in March 1994. The Draft Supplemental CI Report was issued in August 1994. A final supplemental report was not issued. This phase of investigation related to groundwater, surface water, and soil impacts in all Areas of the Site. Copies of these reports are provided on the CD in Appendix C.

**3.2.9 Corrective Action Study Report**

A Corrective Action Study (CAS) was prepared and submitted to KDHE in March 1995. The CAS provided a review of existing site characterization data, discussion of potential corrective action options, review of applicable regulations, and estimated costs for implementation of available options. The selected corrective action included extending the existing subsurface drain system to the east along the north sides of the Area B ponds and operation of three pumping wells to maintain hydraulic control in the alluvial aquifer and in shallow sediments containing groundwater.
A Corrective Action Plan (CAP) was prepared and submitted in 1997. The proposed remedy was approved by KDHE on the premise that plant operations would continue and the assumption that recovered groundwater recycle and reuse in plant processes would be possible. Construction and operation of the groundwater interception and containment system was designed to prevent further impact to the alluvial aquifer associated with the Kansas River from nitrogen compounds originating on the Site. The remedy was implemented beginning in February 1998.

This phase of work related to groundwater impacts in Area A and Area B. A copy of this report is provided on the CD in Appendix C.

3.2.10 CRS pH Study Report

The CRS unit was closed in 1987; however, it could not receive clean closed status due to chromium concentrations detected in groundwater above acceptable limits. Since corrective action and monitoring was implemented following closure, the chromium concentrations declined to below the action level, although low pH levels persisted. To help mitigate the low pH condition, a water injection system was proposed in 2005 to allow water to flow under natural hydraulic gradient though the subsurface in the CRS unit. The objective of the injection system was to reduce the degree and extent of acidic conditions in shallow groundwater, with the ultimate objective that mitigation of the low pH condition will result in the achievement of clean closure for the CRS unit and designation by the KDHE that no further remedial action is required.

A detailed study of pH in the subsurface was undertaken in October 2005 to support the design and construction of the water injection system. Eleven direct-push soil borings were completed in the area of the known low pH plume. All borings were advanced to refusal depth, which ranged from 6 to 12 feet below ground surface.

Results of the investigation showed that soil pH in the fill material ranged from 3.78 to 8.28, with a mean pH of 7.34. Soil pH decreased with depth in most of the boreholes and was generally between 4 and 6 in the native soil, particularly in the silt above the bedrock. Soil pH in the native soil ranged from 3.88 to 8.29 with a mean pH of 5.34. Groundwater pH ranged from 4.21 in monitoring well MW-2 to 7.15 in monitoring well MW-4. Groundwater pH ranged from 6.00 to 7.14 in the other 10 monitoring wells. Grain size analysis was also performed on some samples.

Soil pH was found to be low in the silty sediment, generally 6 to 8 feet below ground surface, immediately overlying the bedrock. Soil pH in the fill material above the silt was found to be greater than 7 and did not require treatment. Treatment of low pH soils therefore focused on the silty zones west of the drainage ditch. During the field investigation, no groundwater was found above the soil-bedrock interface. Based on the results obtained, a potable water injection well array was designed and installed on the up-gradient side of the CRS unit.

Details of the CRS unit remedial operations and monitoring results are provided in Section 6.15.

3.2.11 Site Characterization Report

Following the bankruptcy of Farmland Industries and establishment of the FI Kansas Remediation Trust, an evaluation of the existing conditions was made and a strategy was developed for advancing the Site toward remediation and redevelopment, since the property was no longer used for the manufacturing of fertilizer. A Strategy Document submitted to KDHE in November
2004 became the basis for future site characterization and remedial action work. The purpose of the site characterization activity was to collect sufficient data to determine the potential contribution of environmental impacts to surface water and groundwater quality and potential human health impacts and to identify the aerial and vertical extent of the targeted analytes at the property. A major focus of the site characterization was identification of surface and subsurface soil source areas that may be contributing to environmental impacts to surface water and/or groundwater. In support of these objectives, the site was classified into six Areas based on former property use and/or natural site boundaries. The site Areas are described in Section 3.1.

A work plan for the site characterization effort was submitted to KDHE in January 2005 and revised in February 2005. The targeted analytes for site characterization were nitrates, ammonia, RCRA-list metals, total petroleum hydrocarbons (TPH), volatile organic compounds (VOC), and polychlorinated biphenyls (PCB).

Upon completion of field activities, 404 sample locations were sampled, generating over 1,200 samples. These samples were submitted for analysis for the following constituents:

- 838 soils, 184 sediment and 68 groundwater samples were analyzed for Nitrate plus Nitrite and Ammonia as Nitrogen;
- 153 sediment samples were analyzed for TKN;
- 82 soils, 165 sediment and 15 groundwater samples were analyzed for RCRA metals;
- 54 sediment samples were analyzed for Hexavalent chromium;
- 33 soil and 3 sediment samples were analyzed for TPH;
- 22 soil and 19 sediment samples were analyzed for VOCs; and
- 4 soil samples were analyzed for PCBs.

Groundwater impact was also assessed during the site characterization. Impacted groundwater was confirmed to be present on the Site. A total of 68 groundwater samples were analyzed for nitrogen compounds (nitrate, nitrite, and ammonia). Nitrate-nitrogen (Nitrate-N) was detected above the USEPA Maximum Contaminant Level (MCL) in 21 of the 39 groundwater monitoring wells and 23 of the 29 direct-push groundwater samples.

Groundwater samples from 14 groundwater monitoring wells were also analyzed for RCRA-list metals (Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver). Arsenic was detected above the MCL in 12 of the 14 wells. No other RCRA metals were detected at concentrations above the MCL.

Nitrate-N concentrations in the silty clay aquifer were highest near the former West Pond and Krehbiel Pond (Area B). An additional area of elevated nitrate-N concentrations was found in the vicinity of the former No. 2 Urea Bulk Warehouse (Area D). Ammonia-N concentrations were also highest near the West Pond and Krehbiel Pond. The area around the No. 2 Urea Bulk Warehouse was observed to have elevated ammonia-N concentrations.

Nitrate-N concentrations in the alluvial aquifer were found to exceed the MCL only in the northwest portion of the property. Similar results were observed for ammonia-N concentrations. Six wells screened in the deep alluvial aquifer were analyzed for arsenic. Arsenic concentrations exceeded the MCL in some samples and were highest in a monitoring well located north of the West Lime Pond.
Nitrate-N concentrations in the bedrock water bearing zone were highest on top of the Sandstone Hill at the former UAN lagoons and concentrate ponds (Area A). Ammonia-N concentrations in the bedrock water bearing zone were elevated in several wells in the Sandstone Hill area. Two wells screened in the bedrock zone were also analyzed for arsenic. The highest arsenic concentrations were slightly higher than the arsenic MCL.

The site characterization concluded that impacted groundwater was localized in several areas that are directly linked to past plant operations that produced ammonia, urea, or stored nitrogen containing materials. These areas are Area A and Area B with the highest concentrations of nitrate and ammonia observed along the north and northeastern perimeter of Area A. The West Extension Pond, West Pond, and Krehbiel Pond areas were observed to have the highest nitrate and ammonia concentrations in groundwater. Elevated nitrate levels in groundwater directly correlated with areas of total nitrogen-impacted soil.

The Site Characterization Report (SCR) dated February 1, 2006, provides documentation of the sampling completed and conclusions drawn from the data. The SCR concluded that three Areas were determined to have not been impacted by former plant operations and require no further action (Areas C, E, and F). Further discussion of these Areas is provided in Section 5.

The remaining areas of the Site were determined to require additional evaluation. Some of these areas were considered for interim measures (see Section 6), and other areas were identified for supplemental sampling and investigation (see Sections 3.2.12 through 3.2.15). The Areas of Interest identified in the Site Characterization Report were as follows:

**Area A**
- Central Ponds
- UAN AST/Former Concentrate Ponds Area
- Bag Warehouse Area
- Northern Reach of Primary Drainage Ditch

**Area D**
- Urea Runoff Storage Vault and Urea Production Area
- Oil Pond
- Spill Pond
- Catalyst Landfill
- Ammonia Production-Primary Reformer Area

This phase of investigation related to site-wide surface water, groundwater, and soil impacts. A copy of this report is provided on the CD in Appendix C.

### 3.2.12 Supplemental Groundwater Sampling Report

In response to data needs identified in the Site Characterization Report and previous investigations, a groundwater investigation was performed in the area immediately adjacent to the northern boundary of the Site. In response to a KDHE request, a limited subsurface investigation was completed using direct-push sampling techniques to determine if nitrate and ammonia were present down gradient of the Site. This work was completed in March 2006.
Fifteen groundwater samples were collected from the agricultural fields immediately north of the Site. The samples were collected along transects parallel to the general shallow groundwater flow direction. Groundwater samples were analyzed for ammonia-nitrogen and nitrate-nitrogen. In addition, electrical conductivity logs were obtained from selected boring locations to aid in development of detailed stratigraphic cross sections of the water bearing zones, specifically to determine the extent of the silty clay groundwater unit.

From the groundwater investigation it was concluded that off-site groundwater concentrations are significantly lower than on-site concentrations. The MCL for target compounds were exceeded in only two locations. The chemical data obtained from this investigation supports the conclusion that the interceptor trench/French drain system and recovery wells are effective in containing nitrate-impacted groundwater and preventing further off-site migration.

This phase of investigation related to off-site groundwater impacts. A copy of this report is provided on the CD in Appendix C.

3.2.13 Geologic Characterization of Sandstone Hill

In response to data needs identified in the Site Characterization Report and previous investigations, a field investigation and data evaluation was completed for the geologic characterization of the Sandstone Hill located in Area A. This work was completed in May 2007.

The objective of this work was to evaluate the potential presence of a nitrogen source or sources on the top of the Sandstone Hill and to better define the occurrence of nitrate-bearing and ammonia-bearing groundwater in the area. The investigation focused on determining the flow paths and potential hydraulic connection of subsurface layers in the hill by using high-definition stratigraphy from three soil borings and downhole geophysical logs of these borings. In addition, an investigation was conducted to identify and locate surface seeps around the Sandstone Hill area.

The stratigraphy of the hill area was found to consist of a thin veneer of silt and clay underlain by Tonganoxie Sandstone Member of the Stranger Formation. The Tonganoxie Sandstone consists of soft, fine to medium grained quartz sand and is silty and micaceous in part. Bedding planes range from a few inches to a few feet in thickness and interbedded gray shale and siltstone beds are present within the sandstone. The Tonganoxie Sandstone is underlain by the Weston Shale, which consists of soft, thin bedded, fissile, micaceous, gray to black shale.

Samples collected from the borings on the Sandstone Hill indicated that nitrate-nitrogen and ammonia-nitrogen concentrations on the hill are lower than samples taken from the interceptor trenches northeast of the hill. It was concluded that a contributing source for the impacts to the interceptor trenches could be related to sources in the old process area of the plant located to the south and southeast of these trenches.

This phase of investigation related to groundwater flow and conditions primarily in Area A. A copy of this report is provided on the CD in Appendix C.
3.2.14 Supplemental Soil Investigation

In response to data needs identified in the Site Characterization Report and previous investigations, a soil investigation was conducted to provide additional data necessary to identify whether remedial action was needed within the footprints of the former cooling towers, ammonia plant, urea plant or nitric acid plant, as well as beneath the former urea storm water vault. Samples were also collected in the vicinity of the urea plant and ammonia plant to provide better delineation of impacted areas identified in the 2005 site characterization. This work was completed in September-October 2007.

Surface and shallow subsurface samples collected from beneath former cooling towers were analyzed for RCRA-list total metals and hexavalent chromium. Maximum sample depth from cooling towers was 3 feet below grade. Samples from other areas around the plant were collected from surface, shallow subsurface, and deeper subsurface at 3-foot intervals until refusal (bedrock). Refusal depth data was used to characterize subsurface bedrock topography in the urea and ammonia plant areas.

Following this supplemental investigation, it was concluded that the cooling towers had not adversely impacted the shallow soils within their respective footprints and that no further action on the former tower areas was necessary. The investigation found that a bedrock trough is present beneath the former urea plant and contains elevated nitrate and ammonia concentrations. A small area of elevated nitrate and ammonia concentrations was also noted east of the former ammonia plant area.

A report of the findings was submitted to KDHE on October 25, 2007. This phase of investigation related to soil impacts in Area D and a small part of Area A. A copy of this report is provided on the CD in Appendix C.

3.2.15 KDHE Supplemental Investigation

In late September and early October 2008, KDHE completed an investigation of groundwater and soil to further characterize several data gaps that were identified during review of the RAP and a tour of the Site. The data gathered complements data collected previously from the Site and provides both regulators and prospective purchasers a better understanding of the environmental issues in these areas.

The investigation included soil and groundwater sampling around a newly identified landfill (identified as the “Original Landfill” on early facility drawings), soil and groundwater sampling downgradient of the former paint shop, groundwater sampling in the vicinity of the Krehbiel Pond and monitoring well PW-04A, groundwater sampling in a buried drainage channel that exists near the southeast corner of the #2 Urea Plant, identification and sampling of several former trash dump sites, and sampling of one domestic well downgradient of the Site.

The investigation performed in the area of the Original Landfill confirmed the presence of the landfill. Arsenic was identified in two groundwater samples and lead was identified in one groundwater sample at levels above RSK values in this area. Nitrate concentrations were all below the RSK values. However, a high ammonia concentration in one groundwater sample
accompanied by a strong ammonia odor in the soil detected during the sampling event in this area may indicate that this is a source area for ammonia.

The investigation downgradient of the former paint shop did not reveal concentrations of compounds analyzed for at levels above the RSK values.

Groundwater sampling performed in the vicinity of Krehbiel Pond indicates the current groundwater extraction well system is controlling the migration of nitrate impacts off-site to the north. This investigation was expanded to the west to evaluate potential migration of nitrogen compounds from the extreme northwestern portion of the site. The results of three groundwater samples collected north of the Bag Warehouse indicates that migration off-site of nitrogen compounds may be occurring in this area.

Groundwater sampling near the unconsolidated channel trending northeast from the #2 Urea Plant to near the ponds did not identify nitrate concentrations above RSK values. Therefore, under current conditions, the channel does not appear to be acting as a migration pathway.

The investigation of the former trash dump area included a geophysical investigation of the area as well as subsequent groundwater sample collection. The geophysical survey results indicated the presence of two trenches in the area approximately 350 feet in length north-south by approximately 10 to 15 feet in width east-west. The trenches appeared to be approximately 50 feet apart. One of four groundwater samples in the area identified nitrate concentrations above RSK values according to field screening results and verification analysis at the KDHE Laboratory, suggesting that the area may be another source for nitrate contamination.

One groundwater sample was collected from a domestic farm well located at 1662 N. 1500 Road, which is located downgradient to the north-northwest of the Site. Nitrate concentrations detected in the sample were below the RSK values.

Results of the KDHE investigation are discussed in more detail, as appropriate, in the relevant subsections in Section 7.0. The KDHE Supplemental Investigation Report dated October 27, 2008, and the memo regarding analysis verification dated November 14, 2008, are contained in Appendix C.
4.0 Remedial Action Goals

Remedial Action Goals were determined for the Site based on an evaluation of the contaminants of concern, the media impacted, human health and environmental exposure pathways, and land use. As previously discussed, the financial limitations of the Trust and the large areas of contamination requiring remediation will limit the ability to achieve the ultimate remediation goal to allow unrestricted use at the site in the short-term. It is possible that the ultimate remediation goal may be reached in near-surface soils in the long-term (greater than 30 years) through natural degradation and plant uptake of the contamination and by addressing additional source areas through future development activities. The following considerations were used in evaluating remedial action goals for the Site:

- Historical and current land use is industrial.
- LURs exist at previously closed portions of the Site (landfills) and Site-wide LURs will be placed on the Site.
- The primary contaminants of concern (COCs) are nitrate and ammonia which are subject to rapid degradation at the soil surface; but will leach into the groundwater from contaminated unsaturated soils.
- Ammonia in soil will eventually convert to nitrate through a process of nitrification.
- An existing groundwater containment system will capture nitrate leached from the unsaturated soils to the groundwater.
- Elevated ammonia concentrations present in shallow soils (0 to 6 feet) represent a potential risk to human health through the inhalation of ammonia that volatilizes from the soil.
- Elevated nitrate and nitrite concentrations present in groundwater represent a potential risk to infants through ingestion of drinking water contaminated by nitrate and nitrite.
- No drinking water wells are located on the 467 acres. Drinking water wells are located downgradient of the Site and sampled on a periodic basis.
- Elevated nitrate concentrations present in surface soil will affect the nitrate mass loading levels associated with storm water runoff from the Site.

4.1 CONTAMINANTS OF CONCERN

The primary COCs for the Site are nitrate and ammonia because of the fact that these contaminants have been identified at elevated concentrations in surface and subsurface soil, groundwater, and surface water. While seldom detected at the Site, nitrite is likely also present as an ephemeral intermediary chemical in the nitrogen cycle.

The element nitrogen is an important nutrient and an essential building block in the synthesis of protein and growth for most living organisms and makes up approximately 80 percent of the earth’s atmosphere. Nitrate develops from organic nitrogen in a three-step process called nitrification. The first step of the process is the conversion of organic nitrogen to ammonia; followed by the microbial oxidation of ammonia to nitrite; and finally the conversion of nitrite to nitrate. The process is generally aerobic and is aided by bacterial action.
Denitrification is the biological transformation of nitrate or nitrite to gaseous forms of nitrogen (e.g., nitrogen gas) in a series of steps, each of which loses oxygen. Denitrification occurs in the unsaturated zone, where high organic matter content, abundant nitrate, and appropriate bacteria are available. Denitrification is inhibited by the presence of oxygen in the soils, and therefore occurs under anaerobic conditions.

Nitrate is subject to rapid degradation at the soil surface; however, in the subsurface (unsaturated zone) where oxygen is present, ammonia is eventually converted to nitrate which will readily move with percolating water downward to groundwater. Nitrate is not absorbed by clayey soils because both the clay particles and the nitrate anions have a negative charge, causing nitrate to easily move in a clayey environment. The rate and amount of nitrate in soil that eventually reaches groundwater is a function of the vertical variability of the soil composition, the concentration of nitrate in the soil, precipitation and subsurface water movement, plant utilization, and the subsurface processes of nitrification and denitrification. Nitrate in groundwater is not easily degraded and is chemically nonreactive with other compounds.

Ammonia is the most reduced form of inorganic nitrogen and exists under standard temperature and pressure as a colorless gas with a sharp characteristic odor. Ammonia present at elevated levels in soil readily undergoes transformation to nitrate through nitrification in the presence of oxygen and can be taken up by plants. However, ammonia in very high concentrations in soil will adsorb to soil particles and take a longer time to go through the transformation process. Ammonia that remains in soil in high concentrations can be volatile when exposed to the atmosphere. Common forms of ammonia in water include dissolved ammonia and the ammonium ion.

The USEPA has established a drinking water standard of 10 milligrams per liter (mg/L) nitrate as nitrogen, which KDHE has adopted as the groundwater cleanup goal. KDHE has adopted soil cleanup guidelines in consultation with Kansas State University agronomy experts. These guidelines are documented in the KDHE publication, “Risk-Based Standards for Kansas” known as the RSK Manual. Generally the following guidelines are used:

- In areas where no vegetation is present, such as a parking lot, 85 milligrams per kilogram (mg/Kg) total nitrate plus ammonia is applicable to the upper 8 inches of soil and 40 mg/Kg total nitrate plus ammonia is applicable below 8 inches.
- In areas where vegetation is present, such as a field, 200 mg/Kg total nitrate plus ammonia is applicable to the upper 24 inches of soil and 40 mg/Kg is applicable below 24 inches.
- It is important to note that KDHE will consider site-specific conditions when determining appropriate response actions for a site contaminated by nitrate and/or ammonia.

The USEPA has not established a drinking water standard for ammonia but has established site-specific preliminary remediation goals for ammonia-contaminated soil at this Site. These goals are based on the volatilization potential of ammonia and include 385 mg/Kg for a construction/utility worker; 4,500 mg/Kg for an industrial outside worker; and 1,060 mg/Kg for a resident. These goals and their derivation are outlined in a memorandum from USEPA to KDHE dated December 1, 2008 (see Appendix D).
Arsenic is the only other COC identified at the Site. Concentrations of arsenic which exceed RSK values at the Site are interpreted to be of natural origin, as arsenic was not utilized by any processes at the former nitrogen plant, although small amounts of arsenic were present in catalyst waste that was removed from the Site and disposed off-site during an interim removal action (see Section 6.13). Naturally-occurring inorganic arsenic is well-documented in geologic materials, and arsenical herbicides have been in common use in the U.S. since the 1950’s.

Properties of arsenic result in the environmental partitioning of arsenic into soil and sediment and adsorption onto iron oxide minerals, causing it to become immobile under oxidizing conditions. Leaching of arsenic from soils is more pronounced in sandy soil than in clay loams (Sanok et al. 1995). The presence of arsenic in groundwater and surface water is commonly the result of natural weathering of rocks and soil but can also result from anthropomorphic processes, including coal combustion, metal smelting, and urban runoff.

Other constituents, including fuel and solvent compounds, other metals, and polychlorinated biphenyl compounds, have also been detected at the site. Because of the infrequency of detection of these other constituents and the fact that most were detected at concentrations below the non-residential Risk-Based Standards for Kansas values used for comparison at this site, these other constituents are not further discussed in this RAP. Detailed information concerning historical contaminant detections at the site is included in various investigation documents, particularly the 2005 Site Characterization Report, available for review at KDHE’s Topeka office.

4.2 IMPACTED MEDIA

As described in the previous section, site characterization data has documented nitrate and ammonia impacts to surface and subsurface soils, nitrate and ammonia impacts to sediments in ponds and drainages, nitrate impacts to groundwater, and nitrate impacts to storm and surface water.

Elevated concentrations of arsenic have also been documented in pond sediments and groundwater. Environmental sampling conducted during Site Characterization activity in 2005 identified arsenic in groundwater and pond sediment at concentrations above the non-residential RSK values. Twelve groundwater samples collected from on-site monitoring wells exhibited arsenic concentrations up to 0.0411 mg/L. Arsenic concentrations slightly above the non-residential RSK were also detected in sediment at one location in the East Lime Pond. No other organic or inorganic constituents were detected in any media above the respective non-residential RSK values.

4.3 HUMAN HEALTH PATHWAY EVALUATION

The human health pathway evaluation consisted of two steps: a toxicity assessment and an exposure assessment.
4.3.1 Toxicity Assessment

The toxicity assessment presents the potential human health effects with respect to exposure to nitrates and ammonia in each media at the Site. As a pure product or as a fertilizer, material safety data sheets (MSDS) indicate that the ammonium nitrate can cause irritation through ingestion, inhalation, and contact with the skin and eyes. The primary target of nitrate toxicity, however, is the red blood cell. When nitrates are introduced into the body, nitrate is converted to nitrite and the iron in the hemoglobin of the red blood cell is oxidized to form methemoglobin. Once methemoglobin is formed, the molecule loses its ability to transport oxygen. The resulting condition is methemoglobinemia (ATSDR, 2007; WHO, 2007).

The association between methemoglobinemia and nitrates was determined from a number of human epidemiological surveys in which infants had been exposed to nitrates in contaminated well water (USEPA, 2007). Infants younger than 4 months old are particularly susceptible to developing methemoglobinemia (ATSDR, 2007). On the basis of data from these surveys, USEPA has established a Maximum Contaminant Level (MCL) for drinking water of 10 mg/L. In addition, USEPA has derived a reference dose of 1.6 mg/kg/day in the Integrated Risk Information System (IRIS) (USEPA, 2007). These levels are considered to be low enough to be protective of infants as the most sensitive population.

Health effects related to exposure to nitrates in environmental media have primarily been documented for the route of ingestion. Although exposure to nitrates through inhalation of dusts and dermal contact with soil and water are possible, information regarding chronic effects associated with these pathways is not available. Surface soil, subsurface soil, ground water, storm water, and surface water at the Site are evaluated with respect to potential exposure pathways and nitrate toxicity in the following sections.

Health effects related to exposure to ammonia (NH₃) in environmental media are not well documented. Oral reference doses are not available for any duration of exposure, and the carcinogenic potential of ammonia has not been evaluated. Continuous inhalation exposure reference concentrations for ammonia have been published by EPA’s Integrated Risk Information System and Provisional Peer Reviewed Toxicity Values. There is no toxicity information available for ammonium ion (NH₄⁺).

On December 1, 2008, EPA Region 7 issued a memorandum which established, for decision-making purposes only, preliminary remediation goals (PRGs) for ammonia in soil at the Site, assuming direct contact of a human receptor (see Appendix D). Non-carcinogenic PRGs were determined for three inhalation exposure scenarios — industrial outdoor worker, construction worker, and resident. Inhalation exposure to surface soils was considered likely for all three receptors, and exposure to subsurface soils were considered for the construction worker scenario. Incidental ingestion and dermal contact were not considered due to inadequate toxicity data for these routes of exposure. Chronic and subchronic reference concentrations for volatile ammonia were obtained from the EPA Integrated Risk Information System (USEPA, 2008a) and from the EPA Provisional Peer Reviewed Toxicity Values (USEPA, 2008b). In both cases, the reference concentrations are based on “lack of evidence of decreased pulmonary function or changes in subjective symptomatology”. According to the U.S. Agency for Toxic Substances and Disease Registry, no health effects have been found in humans exposed to typical environmental
concentrations of ammonia. Exposure to high levels of ammonia may cause irritation to skin, eyes, lungs, and throat. Inhalation of extremely high concentrations of ammonia can cause lung damage.

In addition to nitrogen compounds, arsenic was detected at concentrations above RSK screening levels in some pond sediment and groundwater associated with the Site. Exposure to inorganic arsenic can cause various health effects, such as irritation of the stomach and intestines, decreased production of red and white blood cells, skin changes, and lung irritation. It is suggested that the uptake of significant amounts of inorganic arsenic can increase the chances of cancer development, especially the development of skin cancer, lung cancer, liver cancer and lymphatic cancer. Arsenicosis is a chronic illness resulting from drinking water with high levels of arsenic over a long period of time. It results in various health effects including skin problems, skin cancer, cancers of the bladder, kidney and lung, and diseases of the blood vessels of the legs and feet, and possibly also diabetes, high blood pressure, and reproductive disorders.

4.3.2 Human Health Exposure Pathway

The exposure assessment consists of identifying potential exposure pathways at the Site. An exposure pathway describes the course a chemical takes from the source to the exposed individual, and is defined by four elements:

- a source and mechanism of chemical release to the environment;
- an environmental transport medium for the released chemical;
- a point of potential contact with the contaminated medium (referred to as the exposure point); and
- an exposure route at the contact point.

Potential human exposures to nitrates and ammonia at the Site are assessed for surface soil, subsurface soil, groundwater, storm water, and surface water.

4.3.2.1 Surface Soil

Currently, potential exposure pathways to surface soils could occur primarily by: (1) incidental ingestion of soil by industrial or construction personnel; (2) dermal contact with the soil by industrial or construction personnel; and (3) inhalation of wind-borne particulates by industrial or construction personnel. Therefore, the only individuals that could be exposed through these potential surface pathways are industrial personnel and construction workers working on the Site. In the future, the Site will be used for non-residential purposes, so the exposure pathways would be similar to those described above.

There are currently no screening or cleanup levels available for direct contact with nitrates in soil (KDHE, 2007; USEPA, 2004). In addition, no information regarding chronic health effects because of inhalation or dermal absorption of nitrates from soil is available. Because nitrate-containing compounds in the soil are generally soluble, they tend to migrate with water. Therefore, the primary concern with nitrate in surface soil is not human health, but rather the potential for nitrate to migrate to ground and surface water, where it can pose an exposure threat to human and environmental receptors.
Low levels of ammonia in soil are taken up by plants or transformed by microbes into nitrate and nitrite. High levels of ammonia can pose a health risk to humans when exposed. The state of Kansas (KDHE, 2007) does not identify a RSK value for ammonia in any medium. However, USEPA publishes a screening level for ammonia in soil based on inhalation of particulate matter ($6.0 \times 10^8$ mg/kg; USEPA Regional Screening Tables). USEPA Region 7, responding to a request from KDHE, developed site-specific soil PRGs for the Site that are protective of human health based on volatilization of ammonia in outdoor industrial worker and construction worker exposure scenarios. The primary exposure pathway of concern for ammonia in soil is by construction and underground utility workers in close proximity with surface and subsurface soils, such as in an excavation or trench.

### 4.3.2.2 Subsurface Soil

Currently, potential exposure pathways to subsurface soil could occur primarily by: (1) incidental ingestion of soil by construction workers during excavation; (2) dermal contact with the soil by construction personnel; and (3) inhalation of dust during excavation by construction workers. In the future the Site will be used for non-residential purposes so the exposure pathways would be similar to those described above. Similar to surface soil, the primary concern with nitrate in subsurface soil is not human health, but rather the potential for nitrate to migrate to ground and surface water, where it can pose an exposure threat to human and environmental receptors.

Low levels of ammonia in soil are taken up by plants or transformed by microbes into nitrate and nitrite. High levels of ammonia can pose health risk to humans when exposed. The state of Kansas (KDHE, 2007) does not identify a RSK value for ammonia in any medium. However, USEPA publishes a screening level for ammonia in soil based on inhalation of particulate matter ($6.0 \times 10^8$ mg/kg; USEPA Regional Screening Tables). USEPA Region 7, responding to a request from KDHE, developed site-specific soil PRGs for the Site that are protective of human health based on volatilization of ammonia in outdoor industrial worker and construction worker exposure scenarios. The primary exposure pathway of concern for ammonia in soil is inhalation of ammonia vapors by construction and underground utility workers in close proximity with surface and subsurface soils, such as in an excavation or trench.

### 4.3.2.3 Groundwater Pathway

Current use of the property is industrial, and future use is anticipated to be industrial and commercial. There are domestic water supply wells located downgradient of the Site. Potential exposure routes to groundwater could occur primarily by: (1) direct or incidental ingestion through a groundwater well; (2) direct or incidental ingestion by industrial or farm personnel of contaminated water applied to the surface through the land application system, and (3) dermal contact with the groundwater by industrial or construction personnel. Residential use of water on the Site is not considered due to the availability of a municipal water supply; however, as previously mentioned there are domestic water supplies located immediately downgradient of the Site. The MCL for nitrates in drinking water is 10 mg/L. The potential for nitrate toxicity through ingestion and dermal exposure is expected to be negligible on the Site and on fields receiving land application water. There is a risk to domestic water supply users downgradient of the Site. However, continued operation of the current groundwater containment system mitigates this risk.

There are two major human health concerns related to ingestion of nitrate: (1) the occurrence of methemoglobinemia; and (2) potential formation of nitrosamines and N-nitroso compounds, which
are carcinogenic in laboratory test rats. No information on chronic health effects because of dermal absorption of nitrate from water is available. Inhalation of nitrate from ground water is not a viable exposure scenario as nitrate is not volatile and therefore would not form a vapor or gas from contaminated ground water.

The risk of exposure by industrial or farmer workers to land application water is minimal because of the method used for storage and delivery of the water. Exposure to the impacted groundwater on the Site is negligible because the water is delivered from the subsurface directly through pipes into storage tanks. Delivery of the water to the land application sites is performed by remote operation of valves and pumps that does not require contact with the water. As such, the potential for direct or incidental ingestion of land application water is considered negligible.

No screening levels or preliminary remediation goals were found for exposure to ammonia in groundwater.

4.3.2.4 Surface Water Pathway

Current potential exposure routes to surface water could occur primarily by direct contact with water contained in the various pond systems at the Site. Potential exposure routes to surface water could occur primarily by: (1) incidental ingestion by industrial or construction personnel, and (2) dermal contact with the surface water by industrial or construction personnel. In the future the Site will be used for non-residential purposes so the exposure pathways would be similar to those described above. Although ingestion of surface water is possible, the ponds will not be used as a water supply for drinking and will ultimately be closed. Therefore, the potential for nitrate toxicity because of incidental ingestion of surface water is expected to be negligible. No information on chronic health effects because of dermal absorption of nitrate from water is available. Inhalation of nitrate from ground water is not a viable exposure scenario as nitrate is not volatile and therefore would not form a vapor or gas from contaminated ground water.

No information on chronic health effects because of inhalation or dermal absorption of nitrates from water was found.

No information on chronic health effects related to dermal absorption of ammonia from water is available, and no screening levels or preliminary remediation goals were found for exposure to ammonia in surface water. High levels of ammonia in surface water can be toxic to aquatic life, but the level is dependent on pH conditions. The state of Kansas established surface water quality criteria for ammonia in surface water. At neutral pH of 7.0, the ammonia criterion is 36.1 mg/L.

4.3.2.5 Storm Water Pathway

Potential exposure routes to storm water could occur primarily by direct contact with runoff from various surface areas at the Site. Potential exposure routes to storm water could occur primarily by: (1) incidental ingestion by industrial or construction personnel, and (2) dermal contact with the storm water by industrial or construction personnel. Although ingestion of storm water is possible, the storm water will not be used as a water supply for drinking. Therefore, the potential for nitrate toxicity because of incidental ingestion of storm water is expected to be negligible. No information on chronic health effects because of dermal absorption of nitrate from water is available. Inhalation of nitrate from ground water is not a viable exposure scenario as nitrate is not volatile and therefore would not form a vapor or gas from contaminated ground water.
No information on chronic health effects due to dermal absorption of ammonia from water is available, and no screening levels or preliminary remediation goals were found for exposure to ammonia in storm water.

4.3.3 Summary of Human Health Pathway Evaluation

The human health exposure pathways for the Site, based on an industrial setting, can be controlled through the use of LURs. The primary exposure pathway identified for the Site was exposure to the construction worker through the inhalation of ammonia volatilized from subsurface soil. A soil management plan will be developed to provide guidance to future workers at the Site to control possible risks associated with the inhalation of soil contaminated by ammonia.

Off-site migration of groundwater contaminated with nitrate and ammonia is a potential human health exposure pathway if the currently operating groundwater containment system was shut down or not operating. The groundwater containment system is currently serving to control the migration of contaminated groundwater by preventing the water from leaving the Site and discharging water through the land application system and by surface discharge. Both are discussed in more detail in Section 7 of this RAP.

The risk of exposure by industrial or farmer workers to land application water is considered minimal because of the methods used for storage and delivery of the water. Exposure to the impacted groundwater on the Site is negligible because the water is delivered from the subsurface directly through pipes into storage tanks. Delivery of the water to the land application fields is performed by remote operation of valves and pumps that does not require contact with the water. As such, the potential for direct or incidental ingestion of land application water is considered negligible.

LURs and remedial alternatives proposed in Section 7 of this RAP will be used to address these risks.

4.4 ENVIRONMENTAL PATHWAY EVALUATION

Like the human health pathway evaluation, environmental pathways were evaluated to assist in the determination of remedial action goals. This evaluation was performed to understand the contaminant conditions in the various Site media and their effects on other environmental pathways.

Controlling the runoff of nitrate- and ammonia-impacted surface water is a critical remediation goal of the Site. Discharge of nitrogen compounds in storm water ultimately results in the loading of nutrients in the Kansas River. In excess amounts, this can cause an increase in aquatic plant growth and changes in the flora and fauna of the aquatic ecosystem, which can result in hypoxia (low dissolved oxygen levels). High nitrate levels can also directly affect fish and warm-blooded animals.
4.4.1 Environmental Pathways

4.4.1.1 Surface Soil
Nitrate and ammonia impacts to surface soil are observed across the Site. These impacts could limit vegetative growth of grasses and other cover, leach through the soil column to groundwater, further degrade groundwater quality, and be transported with storm water runoff through the storm water management system to the NPDES outfall.

4.4.1.2 Subsurface Soil
Nitrate and ammonia impacts to subsurface soil are observed across the Site. In certain cases, these impacts are observed from ground surface to the water table. These impacts could leach through the soil column to groundwater and further degrade groundwater quality. In addition, subsurface soils can adversely affect surface water through groundwater seeps.

4.4.1.3 Groundwater
Nitrate and ammonia impacts to groundwater are observed across the Site. A groundwater containment system was installed at the northern edge of the Site and is operating to prevent off-site migration of these impacts. As long as this system continues to operate effectively, further degradation of off-site groundwater is not anticipated.

4.4.1.4 Surface Water
The existing pond networks at the Site collect waters from storm events and recovered groundwater. Nitrate and ammonia impacts to surface water are observed in runoff water and within the ponds. These impacts could result in contaminant migration through the soil column to groundwater and further degrade groundwater quality.

4.4.1.5 Storm Water
Nitrate and ammonia impacts to surface soil are observed across the Site. These surface soil concentrations could affect storm water quality where rain water runoff comes into contact with these impacted soils. The storm water is also impacted by groundwater seeps on the northwest and south sides of the Sandstone Hill. These impacts could migrate through the soil column to groundwater, further degrade water quality, and be transported with storm water runoff through the storm water management system to the NPDES outfall.

4.4.2 Environmental Pathway Evaluation Summary
Nitrate and ammonia impacts to soils could leach to groundwater or appear as surface seeps. Surface soil impacts could affect storm water quality. Groundwater impacts are observed across the Site. A groundwater containment system was installed at the northern edge of the Site to prevent off-site migration of these impacts. As long as this system continues to operate effectively, further degradation of off-site groundwater is not anticipated. The storm water pathway is affected by the areas of surface soil impacts across the Site. Storm water is also impacted by groundwater seeps on the northwest and south sides of the Sandstone Hill. The impact to this pathway is mitigated through modifications to the storm water drainage in these areas to segregate the impacted storm water from non-impacted storm water. Non-impacted storm water will be allowed to pass through the Site with discharge to the Kansas River.
Impacted storm water will be captured, contained, and ultimately disposed of through land application for beneficial use of the nitrogen.

Subsurface soils impacted by nitrate and ammonia could leach to groundwater and provide a continued source for the groundwater impacts identified at the Site. The impact to the groundwater pathway is mitigated by the current groundwater containment system which captures the impacted groundwater at the down gradient end of the Site. The most heavily impacted groundwater is captured in interceptor trenches and transferred to storage for eventual use in the land application system. Deeper groundwater which is less impacted is direct-discharged to the surface under an NPDES permit. As long as this groundwater containment system continues to operate properly, degradation of groundwater migrating off the Site is not anticipated.

4.5 LAND USE

The historical and current land use at the Site is designated as industrial. The anticipated future land use at the Site is expected to be a combination of commercial and industrial. LURs will be placed on the property to restrict future residential use because of the fact that limited funding exists to remediate the Site to residential standards. LURs will ensure that the property will remain protective to human health and the environment based on the selected remedial alternative. In the future, LURs can be modified for specific areas of the Site if it is determined that contaminants have degraded or that the migration of contamination is no longer a threat.

4.6 SITE-SPECIFIC REMEDIAL ACTION GOALS AND CLEANUP STANDARDS

Site-specific remedial action goals have been evaluated to minimize or eliminate exposure to human health and environmental pathways. While there are certain published cleanup standards for nitrate and ammonia, the goals are more Site-specific in nature and focused upon feasibility within the framework of the limited available funding for active remedial measures at the Site. The ultimate long-term cleanup goal for all affected media at the Site is unrestricted use of the Site; however, based on the funding limitations, remedial action goals were evaluated for commercial/industrial future land uses.

4.6.1 Surface Soil Remedial Action Goals and Cleanup Standards

Currently, KDHE has RSK surface soil standards for nitrate and ammonia. These standards were developed to be protective of soil impacts migrating to groundwater. These standards are:

- In areas where no vegetation is present:
  - Upper 8 inches of soil - 85 mg/kg total nitrate plus ammonia
- In areas where vegetation is present:
  - Upper 24 inches of soil – 200 mg/kg total nitrate plus ammonia

Previous investigations have identified numerous areas of surface soil impacted by nitrates plus ammonia across the Site that exceed the KDHE RSK surface soil standards. Ammonia can also pose a risk to human health under certain exposure scenarios. The EPA calculated Site-specific
Preliminary Remediation Goals ("PRGs") for ammonia in soil based on the inhalation exposure pathway. The Site-specific PRGs are 385 mg/kg ammonia for the construction worker and 4,500 mg/kg for the industrial outside worker. A residential goal was also established but is not applicable since the future use of the site will be limited to commercial/industrial.

The ultimate remedial action goal for surface soil is to restore surface soil to a condition allowing unrestricted use through active and passive means. However, as previously discussed, there is a limited amount of funding for active remediation of these impacts and not all areas of surface soils that exceed the RSK standards can be addressed through active remediation. Achieving the ultimate remedial action goal will likely take more than 30 years.

Based on funding limitations, remedial actions have been prioritized with guidance from KDHE and EPA to pursue the following primary remedial action goals for surface soils:

- Long-term protection of groundwater resources, particularly the Kansas River alluvial aquifer;
- Preventing further degradation of surface water, particularly the Kansas River, by controlling the discharge of impacted storm water from the site;
- Controlling on-site worker exposures to contaminated surface soil through a site-wide soil management plan; and
- Limiting future impacts through management of area-specific impacted surface soils.

In support of these remedial action goals with respect to surface soil and within the constraints of limited funding available, the following primary actions will be taken:

- Maintain the existing groundwater containment system, with modifications as discussed in Section 7.1.1, for a minimum period of 30 years to ensure protection of groundwater resources (Kansas River alluvial aquifer). The groundwater containment system has been shown to be effective in mitigating the off-site migration of nitrogen compounds. Therefore, surface soil impacts that may leach to groundwater will be controlled and mitigated through the operation of the groundwater containment system.
- To minimize the volume of storm water runoff that comes into contact with impacted surface soils, actions will be taken to segregate, to the extent possible, the storm water runoff from areas of the site where impacted surface soils exist. This segregated storm water runoff will be contained and beneficially re-used for the fertilizer value on agriculture fields through the current land application program. The land application program will be maintained for an assumed period of 30 years.
- LURs will be placed in areas where surface soil impacts exceed KDHE RSK standards to control the future use of these areas of the Site and prevent exposure to or movement of impacted soils above the RSK standards without proper management. A soil management plan will be developed to guide future property owners in the proper handling and management of contaminated surface soil.

These measures alone will likely not achieve the ultimate remedial action goal of unrestricted use. Secondary remedial actions such as soil excavation in source areas should be performed to
reduce the amount of time required to achieve the ultimate goal if funding becomes available through a property transaction.

Through the primary and secondary remedial actions, coupled with previously completed actions, natural degradation processes and other mechanisms (including Site development activities), it is expected that the surface soils at the Site will ultimately be restored to a condition allowing unrestricted use in the long-term (minimum of 30 years).

4.6.2 Subsurface Soil Remedial Action Goals and Cleanup Standards

As with surface soil, KDHE has RSK subsurface soil standards for nitrate and ammonia. These standards were developed to be protective of soil impacts migrating to groundwater. These standards are:

- In areas where no vegetation is present:
  - Below 8 inches of soil – 40 mg/kg total nitrate plus ammonia
- In areas where vegetation is present:
  - Below 24 inches of soil – 40 mg/kg total nitrate plus ammonia

Previous investigations have identified numerous areas of subsurface soil impacted by nitrate plus ammonia across the Site that exceed the KDHE RSK subsurface soil standards. Ammonia can also pose a risk to human health under certain exposure scenarios. The EPA calculated Site-specific Preliminary Remediation Goals (“PRGs”) for ammonia in soil based on the inhalation exposure pathway. The Site-specific PRGs are 385 mg/kg ammonia for the construction worker and 4,500 mg/kg for the industrial outside worker. A residential goal was also established but is not applicable since the future use of the site will be limited to commercial/industrial.

The ultimate remedial action goal for subsurface soil is to restore subsurface soil to a condition allowing unrestricted use through active and passive means. However, as previously discussed, there is a limited amount of funding for active remediation of these impacts and not all areas of subsurface soils that exceed the RSK standards can be addressed through active remediation. Achieving the ultimate remedial action goal will likely take more than 30 years.

Based on funding limitations, remedial actions have been prioritized with guidance from KDHE and EPA to pursue the following primary remedial action goals for subsurface soils:

- Long-term protection of groundwater resources, particularly the Kansas River alluvial aquifer;
- Preventing further degradation of surface water, particularly the Kansas River, by controlling the discharge of impacted storm water from the site; and
- Limiting future impacts through management of area-specific impacted surface soils.

In support of these goals with respect to subsurface soil and within the constraints of limited funding available, the following primary actions will be taken:

- Maintain the existing groundwater containment system, with modifications as discussed in Section 7.1.1, for a minimum period of 30 years to ensure protection of groundwater
resources (Kansas River Alluvium). The groundwater containment system has been shown to be effective in mitigating the off-site migration of nitrogen compounds. Therefore, subsurface soil impacts that contribute to groundwater impacts will be mitigated through the operation of the groundwater containment system.

- Subsurface soil impacts also have the potential to degrade surface water quality as impacted groundwater surfaces in some areas as seeps and impacts storm water runoff. To minimize the impact of these seeps on the storm water runoff quality, actions will be taken to segregate, to the extent possible, the storm water runoff from areas of the site where impacted groundwater seeps exist. This segregated storm water runoff will be contained and beneficially re-used for the fertilizer value on agriculture fields through the current land application program. The land application program will be maintained for an assumed period of 30 years.

- Land-use restrictions (LURs) will be placed in areas where subsurface soil impacts exceed KDHE RSK standards to control the future use of these areas of the Site and prevent exposure to or movement of impacted soils above the RSK standards without proper management. A soil management plan will be developed to guide future property owners in the proper handling and management of contaminated surface soil.

These measures alone will likely not achieve the ultimate remedial action goal of unrestricted use. Secondary remedial actions such as subsurface soil excavation in source areas should be performed to reduce the amount of time required to achieve the ultimate goal if funding becomes available through a property transaction.

Through the primary and secondary remedial actions, coupled with previously completed actions, natural degradation processes and other mechanisms (including Site development activities), it is expected that the subsurface soils at the Site will ultimately be restored to a condition allowing unrestricted use in the long-term (minimum of 30 years).

4.6.3 Groundwater Remedial Action Goals and Cleanup Standards

EPA has an MCL for nitrate of 10 mg/L which is adopted by KDHE. This MCL is driven by toxicity of nitrate impacted water, as discussed in Section 4.3.1.

Previous investigations have identified groundwater impacted by nitrate above the MCL across a majority of the Site. The groundwater remedial action goal is to ultimately restore groundwater quality to a condition allowing unrestricted use through active and passive means which will likely take at least 30 years.

Based on funding limitations, remedial actions have been prioritized with guidance from KDHE and EPA to pursue the following primary remedial action goals for groundwater:

- Long-term protection of groundwater resources, particularly the Kansas River alluvial aquifer including domestic water supply wells located downgradient of the Site;

- Limited reduction of groundwater contaminant mass through extraction and beneficial land application of contaminated ground water using the existing perimeter groundwater containment system; and
• Restricting the construction and use of domestic water supply wells on the Site through LURs.

In support of these goals with respect to groundwater impacts and within the constraints of limited funding available, the following primary actions will be taken:

• Maintain the existing groundwater containment system, with modifications as discussed in Section 7.1.1, for a minimum period of 30 years to ensure protection of groundwater resources (Kansas River alluvial aquifer). The groundwater containment system has been shown to be effective in mitigating the off-site migration of nitrogen compounds and removing contaminant mass.

• LURs will be placed over the entire Site to restrict the installation of groundwater wells used for domestic drinking water purposes on the Site.

• Monitor on- and off-site monitoring wells and active domestic wells to continually evaluate water quality changes in the Kansas River alluvial aquifer, and provide alternate drinking water supplies to affected well users as necessary.

These measures alone will likely not achieve the ultimate remedial action goal of unrestricted use. Secondary remedial actions should be performed to reduce the amount of time required to achieve the ultimate goal if funding becomes available through a property transaction.

Through the primary and secondary remedial actions, coupled with previously completed actions, natural degradation processes and other mechanisms (including Site development activities), it is expected that groundwater quality at the Site will ultimately be restored to a condition allowing unrestricted use in the long-term (minimum of 30 years).

4.6.4 Surface Water Remedial Action Goals and Cleanup Standards

The Kansas Surface Water Quality Standard for nitrate (as nitrogen) is 10 mg/L for a domestic water supply use category. Various pond networks exist at the site, historically for process and storm water management. None have or will be utilized for domestic drinking water supply purposes. The surface water cleanup goal is to prevent further degradation of surface water, primarily the Kansas River, by controlling the discharge of impacted water from the Site.

Based on funding limitations, remedial actions have been prioritized with guidance from KDHE and EPA to pursue the following primary remedial action goals for surface water:

• Long-term protection of groundwater resources, particularly the Kansas River alluvial aquifer;

• Preventing further degradation of surface water, particularly the Kansas River, by controlling the discharge of impacted storm water from the site; and

• Limiting future impacts through engineered management of groundwater seepage areas and excavation of specific source areas.

In support of these goals with respect to surface water quality and within the constraints of limited funding available, the following primary actions will be taken:
• To minimize the volume of storm water runoff that comes into contact with impacted surface soils, actions will be taken to segregate, to the extent possible, the storm water runoff from areas of the site where impacted surface soils exist. This segregated storm water runoff will be contained and beneficially re-used for the fertilizer value on agriculture fields through the current land application program. The land application program will be maintained for an assumed minimum period of 30 years.

• To minimize and/or eliminate impacted groundwater that appears at the surface (in the form of seeps) in various locations around the UAN Storage Area (Sandstone Hill) and negatively impacts surface water quality, actions will be taken to capture this groundwater seepage. The captured water will be contained and beneficially re-used for the fertilizer value through the current land application program, which will be maintained for an assumed period of 30 years.

• LURs will be placed in areas where surface soil impacts exceed KDHE RSK standards to control the future use of these areas of the Site and prevent exposure to or movement of impacted soils above the RSK standards without proper management. A soil management plan will be developed to guide future property owners in the proper handling and management of contaminated surface soil which will help prevent movement of impacted soils above the RSK standards that could affect surface water quality without proper management.

• To minimize contaminated surface water action will be taken to construct a new storm water drainage structure utilizing the former East and West Effluent Ponds as a detention basin. This structure will allow clean surface water, in the form of storm water runoff from non-impacted areas of the Site as well as from areas south of the Site to pass through the Site without coming into contact with impacted soils or sediments.

Secondary remedial actions should be performed to further reduce the potential for degradation of surface water if funding becomes available through a property transaction.

Through the primary and secondary remedial actions, coupled with previously completed actions, natural degradation processes and other mechanisms (including Site development activities), it is expected that the surface water quality at the Site will be improved.

### 4.6.5 Storm Water Goals and Cleanup Standards

Currently, storm water flows through an existing collection system to the East and West Effluent Ponds and is then discharged through NPDES outfall 001B. The NPDES permit has discharge limits for ammonia and nitrates and is scheduled to expire on December 31, 2009. Future plans call for the closure of the East and West Effluent Ponds and the construction of a new storm water drainage ditch and detention basin to manage clean storm water. In the interim, it will be necessary to renew and maintain the NPDES permit for an assumed period of approximately 8 years.

There are currently portions of the Site that yield clean storm water because of the lack of surface soil impacts and there are also areas of the Site that produce impacted storm water resulting from storm water contacting surface soil impacts and/or mixing with groundwater that daylights as
seeps and becomes surface water. The storm water cleanup goal is to ultimately have the quality of storm water exiting the Site be roughly the same quality as the storm water entering the Site by eliminating the mixing of impacted and non-impacted waters.

Based on funding limitations, remedial actions have been prioritized with guidance from KDHE and EPA to pursue the following primary remedial action goals for storm water:

- Long-term protection of groundwater resources, particularly the Kansas River alluvial aquifer;
- Preventing further degradation of surface water, particularly the Kansas River, by controlling the discharge of impacted storm water from the site; and
- Limiting future impacts through engineered management of groundwater seepage areas and excavation of specific source areas.

In support of these goals with respect to storm water runoff quality and within the constraints of limited funding available, the following primary actions will be taken:

- To minimize the volume of storm water runoff that comes into contact with impacted surface soils, actions will be taken to segregate, to the extent possible, the storm water runoff from areas of the site where impacted surface soils exist. This segregated storm water runoff will be contained and beneficially re-used for the fertilizer value on agriculture fields through the current land application program. The land application program will be maintained for an assumed minimum period of 30 years.

- To minimize and/or eliminate impacted groundwater seeps at various locations around the UAN Storage Area (Sandstone Hill) that negatively impact storm water quality, actions will be taken to capture this groundwater seepage. The captured water will be contained and beneficially re-used for the fertilizer value through the current land application program, which will be maintained for an assumed period of 30 years.

- LURs will be placed in areas where surface soil impacts exceed KDHE RSK standards to control the future use of these areas of the Site and prevent exposure to or movement of impacted soils above the RSK standards without proper management. A soil management plan will be developed to guide future property owners in the proper handling and management of contaminated surface soil, which will help prevent movement of impacted soils above the RSK standards that could affect storm water quality without proper management.

- To minimize contaminated storm water, action will be taken to construct a new storm water drainage structure. The structure will utilize the former East and West Effluent Ponds as a detention basin following removal of impacted sediment from these ponds. This structure will allow clean surface water, in the form of storm water runoff from non-impacted areas of the Site as well as from areas south of the Site to pass through the Site without coming into contact with impacted soils or sediments. Until these actions are completed, the existing NPDES permit will be renewed and maintained for an assumed period of approximately 8 years.
Secondary remedial actions should be performed to further reduce the potential for degradation of surface water if funding becomes available through a property transaction.

Through the primary and secondary remedial actions, coupled with previously completed actions, natural attenuation processing and other mechanisms (including Site development activities), it is expected that the storm water runoff quality exiting the Site will ultimately be roughly the same quality as the storm water entering the Site over the long-term.
References for Section 4.0


5.0 Areas Previously Closed or Requiring No Additional Action

Based on the numerous site characterization activities performed at the Site between the years 1974 and 2008, several areas of the Site have been previously closed under KDHE regulatory oversight or are now recommended for no additional action. This section summarizes these areas. Site-Wide LURs will be placed on the entire 467 acres of property to ensure long-term protection of public health and the environment. The Site-Wide LURs will include restrictions to residential development and installation of water wells used for drinking water purposes. In the future LURs can be modified for specific areas of the Site if it is determined that contamination has degraded, is no longer present, or is not threatened by the migration of contamination. Areas recommended for no additional action will not be further evaluated in the RAP.

The locations of all areas referenced in this section are illustrated in Figure 5-1.

5.1 AREAS PREVIOUSLY CLOSED UNDER REGULATORY PROCEDURES

Four former landfills located on the Site have been previously closed by the KDHE. Each of these landfills has existing LURs that govern the future use of those areas. Three of these former landfills are currently considered closed by the KDHE. A brief summary of the history of these landfills and the activities performed as part of the closure activities is provided in the following sections. In 2006, KDHE determined that the fourth landfill required additional work. This activity was completed as an interim action and will be discussed in detail in Section 6.0.

A brief summary of the history of these landfills and the activities performed as part of the closure activities is provided in the following sections.

5.1.1 Lime Sludge Landfill – KDHE Permit #266

Identified as SWMU #4 Sludge Pond/Landfill in the 1993-1994 CI Report, the landfill operated from 1976 through 1981 and received lime sludge from the other Site lime sludge pond (SWMU #6) and possibly sediments from the Site effluent ponds. The landfill, located in the northeastern corner of the Site, was 500 feet by 350 feet and of unknown depth. The location of the Lime Sludge Landfill is illustrated on Figure 5-1.

The Lime Sludge Landfill was taken out of use in 1981 and no releases or evidence of releases were documented during its operation. Following its removal from service, the landfill was covered with native soils to a depth ranging from 2.5 to 6.5 feet. Analytical results for subsurface soil samples collected from this landfill and analyzed for chromium and lead reported chromium at concentrations from 14.1 mg/kg to 16.4 mg/kg and lead concentrations from 16 mg/kg to 19.5 mg/kg. No volatile organic or semi-volatile organic compounds were reported. At the time of closure, the concentrations reported were all below KDHE’s cleanup guidelines for non-residential property use. The status of the landfill, as listed by the KDHE, is “closed post closure completed/not required”.

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A restrictive covenant was filed with the Douglas County Register of Deeds for this landfill on December 10, 2004. The area covered by the restrictive covenant is legally described as:

A tract of land in the Northeast quarter of section 4, township 13 South, range 20 East of the sixth principal meridian, in Douglas county, Kansas, described as follows: Beginning at a point which is South 02° 23’ 47” East, 2141.76 feet along the East line, and South 87° 36’ 13” West, 18.50 feet from the Northeast corner of said quarter section; Thence South 01° 27’ 48” East, 352.12 feet; Thence South 87° 48’ 18” West, 521.92 feet; Thence North 01° 08’ 20” West, 589.87 feet; Thence South 67° 26’ 37” East, 567.69 feet to the point of beginning. Contains 5.629 acres, more or less.

The restrictive covenant establishes that the covered area can only be used as grassland, slab on grade buildings, slab on grade parking, or other future use as approved by KDHE. Any subsequent property owners and/or tenants are required to consult with KDHE during planning of any improvement to the property and to obtain written approval from KDHE before any work is performed on the area covered by the restrictive covenant.

This restrictive covenant will remain in place for this landfill and the area will also fall under the Site-wide LURs developed for the Site.

5.1.2 Solid Waste Landfill – KDHE Permit #243

Referred to as Solid Waste Landfill #1 (SWMU #20), this landfill was operated as a solid waste landfill from 1976 to 1989. This unlined landfill was reported to be 350 feet long by 20 feet wide by 12 feet deep. During its operation, solid waste from offices and operating units were placed into the landfill. The location of Solid Waste Landfill #1 labeled as “Solid Waste Landfill” is illustrated on Figure 5-1

This landfill was closed in 1989 and capped with 2.5 feet native soil seeded to grass. The KDHE indicated during a closure inspection in 1990 that the closure of this landfill had been completed in accordance with state standards.

A restrictive covenant was filed with the Douglas County Register of Deeds for this landfill on December 10, 2004. The area covered by the restrictive covenant is legally described as:

A tract of land in the Southwest quarter of section 4, township 13 South, range 20 East of the sixth principal meridian, in Douglas county, Kansas, described as follows: Beginning at a point which is North 01° 12’ 48” East, 1864.84 feet along the West line, and South 88° 47’ 12” East, 2246.75 feet from the Southwest corner of said quarter section; Thence North 07° 33’ 05” East, 243.33 feet; Thence South 83° 11’ 32” East, 42.92 feet; Thence South 01° 00’ 19” West, 245.71 feet; Thence North 79° 39’ 12” West, 28.15 feet to the point of beginning contains 0.199 acre, more or less.
The restrictive covenant establishes that the covered area can only be used as grassland, slab on grade buildings, slab on grade parking, or other future use as approved by KDHE. Any subsequent property owners and/or tenants are required to consult with KDHE during planning of any improvement to the property and to obtain written approval from KDHE before any work is performed on the area covered by the restrictive covenant.

This restrictive covenant will remain in place for this landfill and the area will also fall under the Site-wide LURs developed for the Site.

5.1.3 Insulation Landfill – KDHE Permit #243

Referred to as Solid Waste Landfill #2 (SWMU #20), was also opened, for one time use, under the same permit as the Solid Waste Landfill #1. This landfill was used one time to accept fiberglass insulation from Ammonia ASTs #301 and #302. The insulation removed from these ASTs was buried in this landfill and covered with native soils. The KDHE has also classified this landfill as properly closed. The location of Solid Waste Landfill #2, labeled as “Insulation Landfill,” is illustrated on Figure 5-1.

A restrictive covenant was filed with the Douglas County Register of Deeds for this landfill on December 10, 2004. The area covered by the restrictive covenant is legally described as:

A tract of land in the southwest quarter of section 4, township 13 south, range 20 east of the sixth principal meridian, in Douglas County, Kansas, described as follows: Beginning at a point which is north 01° 12’ 48” East, 1281.10 feet along the West line, and South 88° 47’ 12” East, 1724.96 feet from the Southwest corner of said quarter section; thence North 10° 26’ 37” East, 69.79 feet; Thence North 68° 35’ 51” East, 77.36 feet; thence North 83° 00’ 20” East, 51.31 feet; thence South 29° 02’ 36” West, 142.00 feet; thence North 72° 29’ 25” West, 69.91 feet to the point of beginning. Contains 0.215 acre, more or less.

The restrictive covenant establishes that the covered area can only be used as grassland, slab on grade buildings, slab on grade parking, or other future use as approved by KDHE. Any subsequent property owners and/or tenants are required to consult with KDHE during planning of any improvement to the property and to obtain written approval from KDHE before any work is performed on the area covered by the restrictive covenant.

This restrictive covenant will remain in place for this landfill and the area will also fall under the Site-wide LURs developed for the Site.

5.1.4 Catalyst Landfill (Portion of Area D) – KDHE Permit #408

The Catalyst Landfill was located in the northern portion of the Operations Area (Area D) and was constructed to receive spent catalysts produced in various operations at the Site. It was identified as SWMU #5 during the RCRA Facility Assessment (USEPA, 1990). The landfill measured approximately 150 feet by 25 feet by 15 feet deep, was unlined, and operated between 1981 and 1989 on an as-needed basis with the approval of KDHE. The landfill was covered with
surrounding soils when not active and upon closure. The KDHE lists the status of this landfill as "closed: post closure care completed/not required". The location of Catalyst Landfill is illustrated on Figure 5-1.

A restrictive covenant was filed with the Douglas County Register of Deeds for this landfill on December 10, 2004. The area covered by the restrictive covenant is legally described as:

A tract of land in the Southwest quarter of section 4, township 13 South, range 20 East of the sixth principal meridian, in Douglas County, Kansas, described as follows: Beginning at a point which is north 01° 12' 48" East, 2072.55 feet along the West line, and South 88° 47' 12" East, 713.32 feet from the Southwest corner of said quarter section; Thence North 02° 10' 58" East, 52.25 feet; Thence North 89° 46' 44" East, 52.81 feet; Thence South 01° 12' 05" East, 53.29 feet; Thence North 89° 06' 42" West, 55.92 feet to the point of beginning. Contains 0.066 acre, more or less.

The restrictive covenant establishes that the covered area can only be used as grassland, slab on grade buildings, slab on grade parking, or other future use as approved by KDHE. Any subsequent property owners and/or tenants are required to consult with KDHE during planning of any improvement to the property and to obtain written approval from KDHE before any work is performed on the area covered by the restrictive covenant.

The catalyst landfill was investigated during the 2005 Site Characterization activities. Surface and subsurface soil samples were collected from the vicinity of this landfill for total RCRA metals analysis. A sample of the catalyst material was retrieved and submitted for TCLP analysis. As a result of the characterization activities, interim remedial measures were performed in the area of the catalyst landfill. The details of these measures are discussed in Section 6.13.

In June 2006, interim remedial measures were completed in the catalyst landfill area. The results of the interim remedial measures, which included the removal of approximately 815 cubic yards of soil, indicated that the catalyst material had been successfully removed. The excavation was backfilled with clean fill material and seeded with native grasses.

Based on the results of the interim measures performed, it appears the area of the catalyst landfill can now be recommended for no additional action and the existing restrictive covenant be modified accordingly. Site-wide LURs will be developed to include this area of the Site.

5.2 AREAS REQUIRING NO ADDITIONAL ACTION

Based on the 2005 Site Characterization activities, various areas of the Site were determined to have not been impacted above applicable RSK standards and are recommended for no additional action. These areas include: 1) 30 acres of farm ground north of the railroad tracks and south of 15th Street; 2) Area C - Northeast Site Area which consists of 77 acres; 3) portions of Area D including the Oil Pond and Spill Pond consisting of 9 acres; 4) an area to the southwest of the main facility consisting of 55 acres located along and north of Highway 10 known as Area E – Southwest Site Area; and 5) portions of Area F located southeast of the main facility consisting of approximately 69 acres. The areas recommended for no additional action consist of
approximately 240 acres of the 467 acres comprising the Site. These areas are discussed in further detail in the following sections.

5.2.1 Farm Ground

The Farm Ground Area is a triangle-shaped area located north of the main facility operation across the railroad tracks and south of 15th Street. This area has always been used as agricultural land and never been a part of the facility operations. The location of the Farm Ground Area is illustrated on Figure 5-1.

It is recommended that no additional remedial action be required for the approximately 30 acres comprising the Farm Ground.

5.2.2 Area C – Northwest Site Area

Area C is located in the northwest Site area and is comprised of approximately 77 acres of grass and wooded land. This area is bordered on the north and east by Area A, on the east by Area F, on the south by Area D, and on the west by the western property boundary. This area has not been used in the past for Site operations. The location of Area C is illustrated on Figure 5-1.

As part of the Site Characterization activities performed in 2005, soil samples were collected from 19 locations across Area C and analyzed for nitrogen compounds and RCRA metals. The analytical results of the 34 soil samples analyzed for nitrogen compounds and the 3 samples analyzed for RCRA metals support that this area was not adversely impacted by former plant operations. Nitrate plus nitrite concentrations were no greater than 12.7 mg/kg and ammonia concentrations no greater than 57.8 mg/kg with these concentrations detected in surface soils. As previously discussed, KDHE’s RSK standards for nitrate plus ammonia in soil is as follows:

- In areas where no vegetation is present, such as a parking lot, 85 mg/Kg total nitrate plus ammonia is applicable to the upper 8 inches of soil and 40 mg/Kg total nitrate plus ammonia is applicable below 8 inches.
- In areas where vegetation is present, such as a field, 200 mg/Kg total nitrate plus ammonia is applicable to the upper 24 inches of soil and 40 mg/Kg is applicable below 24 inches.

There were no other contaminants tested for that were detected above the RSK standards for a non-residential land use setting. Refer to the Site Characterization report for actual analytical data for sampling conducted in this area.

The concentrations of nitrate plus nitrite (less than 12.7 mg/kg), ammonia (57.8 mg/kg), detected in Area C do not pose an adverse risk to surface water, groundwater, or human health.

It is recommended that no additional remedial action be required for the approximately 77 acres comprising Area C. This area will also fall under the Site-wide LURs developed for the Site.

5.2.3 Area D – Oil Pond and Spill Pond

The Oil Pond and Spill Pond are located near the southeast corner of Area D and are approximately 9 acres in size. The Oil Pond was used for fire control training with waste oil used
as the ignitable medium. The Spill Pond was constructed to contain potential spills from the unloading of #6 fuel oil which was used as a backup fuel source. The location of the Oil Pond and Spill Ponds are illustrated on Figure 5-1. As part of the Site Characterization activities performed in 2005, soil samples were collected from three soil boring locations in the Oil Pond and two soil boring locations in the Spill Pond. Three sediment samples were also collected within the Spill Pond.

Three samples collected from the Spill Pond reported Total Petroleum Hydrocarbons ("TPH") as fuel product as high as 4,500 mg/kg. Three surface soil samples in the Oil Pond reported TPH as fuel product as high as 560 mg/kg. KDHE’s RSK standards for TPH as gasoline and diesel range organics in soil for non-residential settings are as follows:

- Non-residential soil pathway standard – 20,000 mg/kg for diesel range and 450 mg/kg for gasoline range.
- Non-residential soil to groundwater pathway standard – 15,000 mg/kg for diesel range and 150 mg/kg for gasoline range.

There were no other contaminants tested for that were detected above the RSK standards for a non-residential land use setting. Refer to the Site Characterization report for actual analytical data for sampling conducted in this area.

As a result of the above sampling results, interim remedial measures were performed at the Oil Pond and Spill Pond between May 10 and June 6, 2006. The interim remedial measures included utilizing 2,000 cubic yards of on-site fill material to restore the surface grade and seeding with native grasses. The details of these measures are discussed in Section 6.14.

Based on the results of the interim measures performed, it appears the Oil Pond and Spill Pond can be recommended for no additional action. The Oil Pond and Spill Pond Area will fall under the Site-wide LURs developed for the Site.

### 5.2.4 Area E – Southwest Site Area

Area E is located in the southwest Site area and consists of approximately 55 acres that border the western boundary of the Site and extends south of the administration building and adjacent to the north of Highway K-10. This area has not been used in the past for Site operations. The location of Area E is illustrated on Figure 5-1.

As part of the Site Characterization activities performed in 2005, soil samples were collected from 13 locations across Area E and analyzed for nitrogen compounds and RCRA metals. The analytical results of the 36 soil samples analyzed for nitrogen compounds and the 3 samples analyzed for RCRA metals support that this area was not adversely impacted by former plant operations. Refer to the Site Characterization report for actual analytical data for sampling conducted in this area.

It is recommended that no additional action be required for the approximately 55 acres comprising Area E. The area will also fall under the Site-wide LURs developed for the Site.
5.2.5 Part of Area F – Southeast Site Area

Area F is located in the southeast Site area and consists of approximately 90 acres of grasslands, shrubs, and natural drainage features. This area is bordered to the south by Highway K-10 and to the east by an industrial park. Most of this area has not been used in the past for Site Operations.

Most of Area F is recommended for no additional action, based on characterization data discussed in Section 3.2.11. This recommendation includes the eastern and southern parts of Area F (approximately 69 acres). There were no contaminants tested for that were detected above the RSK standards for a non-residential land use setting. Refer to the Site Characterization report for actual analytical data for sampling conducted in this area. The approximate boundaries of the 69 acres within Area F are depicted in Figure 5-1.

The area will also fall under the Site-wide LURs developed for the Site.
6.0 Interim Remedial Measures

Based on the numerous site characterization activities performed at the Site between 1974 and 2008, interim remedial measures were or have been identified for several areas of the Site to address environmental issues of immediate concern. This section summarizes those areas and interim remedial measures taken at the Site.

6.1 AREA A - CENTRAL PONDS

The Central Ponds encompass approximately 0.5 acres along the southern boundary of Area A. The Central Ponds were designed to control surface water flow during heavy rain events, serving as temporary flood control features. The ponds intermittently contained surface water runoff as a result of precipitation events but the water drained quickly from these ponds. The surface water flowing from the Central Ponds was determined to contain high levels of nitrogen compounds and as such was previously directed to the East Effluent Pond.

The Central Ponds were not identified for investigation during the RCRA Facility Assessment (RFA) conducted in 1990 (USEPA, September 1990), and they were not sampled during the Comprehensive Investigation completed in 1993-1994. Based on the results of site characterization activities performed at the site from March 2005 to July 2005, total nitrogen contamination was limited to the pond area where total nitrogen concentrations exceeded 10,000 mg/kg. Samples collected from outside the pond had total nitrogen concentrations that did not exceed 100 mg/kg. The data indicated that the contamination in this area was limited to the pond bottoms. Soil borings were sampled to bedrock depth in this area.

The interim remedial measures included the excavation of over 1,300 cubic yards of nitrogen-impacted sediment from the Central Ponds. The interim remedial measure was implemented pursuant to the KDHE approved Interim Measures Work Plan dated March 8, 2006.

The location of the Central Ponds is illustrated on the Site Map provided as Figure 6-1.

6.1.1 Interim Measures

Between May 14 and June 15, 2006 nitrogen-impacted soils were excavated from the Central Ponds and placed in the East Lime Pond in Area B, beginning with the existing fill areas in the south end of the pond. Before relocation of the sediments, the East Lime Pond was dewatered between May 4 and May 11, 2006. Water from the East Lime Pond was discharged to the East Effluent Pond in accordance with the work plan.

Approximately 1,300 cubic yards of impacted sediment were removed from the Central Ponds by excavating to the bedrock interface at a depth of approximately 3 feet. In addition to the pond area, a small 50 square foot area near sample location A01W-SS-53 was also excavated as the area was void of any plant growth. The excavated material was direct-loaded on to trucks and transported to the East Lime Pond in Area B of the Site where it was placed in the south end of the East Lime Pond.

Approximately 2,700 cubic yards of backfill material, obtained on-site, was used to restore the surface grade to eliminate future accumulation of surface water and the resulting deposition of
sediiments. Backfill was placed in 6-inch lifts and track compacted with excavation equipment. An erosion control mat was installed along the central axis of the graded area and the area was seeded with native vegetation. During the excavation and grading process, silt fencing was installed on the downhill side and perimeter of the ponds to minimize erosion and surface runoff of excavated sediments. Silt fencing was installed in accordance with the Kansas Department of Transportation (KDOT) Temporary Erosion-Control Manual.

The interim measures were completed in May and June 2006 with the seeding of native vegetation delayed until early fall 2006 to take advantage of cooler temperatures and seasonal rains to optimize germination of the native grasses. Documentation of the interim measures undertaken at the Central Ponds was provided to KDHE in a report dated September 1, 2006.

The interim remedial measure performed in the Central Ponds is consistent with the proposed final remedy for the Site. Removing sediments containing high concentrations of total nitrogen improved the water quality of surface water exiting the Central Ponds area. In addition, a source area for continued impacts to the shallow groundwater in the area was cost-effectively removed.

6.1.2 Costs

The scope of work associated with the implementation of the interim remedial measure in the Central Ponds was completed for an approximate total cost of $58,460. The scope of work performed included the excavation of approximately 1,300 cubic yards of impacted sediment, transportation of the excavated sediments to the East Lime Pond, backfilling, grading, compaction, installation of silt fencing, and project reporting.

6.1.3 Additional Measures

Subsequent to the completion of the interim remedial measures of the Central Ponds, the area of the Central Ponds has been observed to be “wet” with some occasional standing water. The source of this water is believed to be shallow groundwater migrating southward from the Sandstone Hill area to the north. The groundwater daylightes as a surface seep in the area of the Central Ponds. As the water evaporates, white crystalline material (ammonium nitrate) is observed to form on the surface of the soil in the Central Pond area. The water quality of surface water which flows through this area is negatively impacted by this condition, particularly during the initial flow of a precipitation event. As a result, backfill brought in during the interim remedial measure has been impacted by this highly contaminated water. The Central Pond Area remains as a primary source area for nitrate and ammonia contamination and is proposed for additional action in the RAP. A description of the potential additional remedial measures for the Central Ponds is provided in Section 7.3.2.
6.2 AREA A – REMOVAL OF PONDED WATER AT AST 5 AND AST 6

In November 2006, KDHE requested that drainage modifications be made to the area between AST 5 and AST 6 to eliminate standing water. The standing water resulted from surface water runoff that was retained in this area because of a berm that prevented natural drainage from the area. Samples collected from the standing water indicated ammonia-nitrogen and nitrate-nitrogen were detected at concentrations of 3 milligrams/liter (mg/L) and 18 mg/L, respectively.

On December 14, 2006 a work plan was submitted to KDHE outlining the proposed activities to modify the drainage of surface water from this area. The work plan was approved by KDHE on January 19, 2007.

The location of this area is illustrated on the Site Map provided as Figure 6-1.

6.2.1 Interim Measures

On March 22, 2007, field activities to modify the surface water drainage in this area were initiated and were completed on March 24, 2007. A 10-foot portion of the existing berm between AST 5 and AST 6 was excavated and removed to drain the area of standing water located north of the berm. Approximately 100 cubic yards of soil was removed from the berm breach and the soil was transported and placed in the East Lime Pond.

The area to the north of the berm was graded to direct surface water runoff toward the breach in the berm. Surface water exited the area through the breach and entered an existing drainage ditch to the immediate east of the berm and west of AST 5. Drainage then continues to the south and ultimately enters the main storm water drainage ditch running south to north through the site. Surface water drainage from the area between AST 5 and AST 6 will be directed to the Overflow Pond in the future, along with other surface water runoff from the Sandstone Hill in Area A.

The breach in the berm was stabilized with a non-woven construction fabric and rip rap which was salvaged from the berm modification.

These activities were summarized in a report submitted to KDHE dated May 1, 2007.

6.2.2 Costs

The scope of work associated with the implementation of the interim remedial measure to modify the surface water drainage in the area between AST 5 and AST 6 was completed for an approximate total cost of $37,500 (all of which is included in the total costs for drainage modifications on the Sandstone Hill presented in Section 6.4.2). The scope of work performed included the excavation of approximately 100 cubic yards of soil to create a breach in an existing berm, transportation of the excavated soil to the East Lime Pond, grading of the area to direct surface water runoff to the breach in the berm, installation of construction fabric and rip rap, and project reporting.

6.2.3 Additional Measures

At this time, no additional measures are anticipated to occur with respect to the surface water drainage from this area.
6.3 CLEANOUT, INSPECTION, AND MAINTENANCE OF ABOVEGROUND STORAGE TANKS

Two aboveground storage tanks (ASTs) are currently utilized at the Site for the storage of nitrogen-impacted groundwater and surface water pumped from the groundwater interceptor trenches, Rundown Pond and Overflow Pond directly into the ASTs for beneficial reuse. The water in the ASTs is land-applied by pipeline to a series of center pivots located on agricultural fields north of the Site. Water is collected year round but land applied during the periods before planting of the fields and post harvest (February through April and October through December). AST #5 was constructed in 1990 and has a capacity of 2,500,000 gallons. AST #6 was constructed in 1992 and has a capacity of 5,500,000 gallons. Each AST was historically used for UAN storage. The locations of AST #5 and AST #6 are illustrated on the Site Map provided as Figure 6-1.

In previous years, the ASTs were emptied and internal/external inspections were conducted every two years. Inspections were conducted by either non-API-Certified Farmland personnel or by an outside contractor and included vacuum box exams of welds and ultrasonic thickness tests. Historical repairs included epoxy coating tank bottom repairs every two years.

6.3.1 Interim Measures

In June 2007, the water stored in AST #6 was transferred to AST #5 and AST #6 was taken off-line in preparation for the pending inspection and repairs. The tanks must be inspected and repaired on different dates as both tanks cannot be taken out of service at the same time because of the constant groundwater and surface water mitigation activities. The non-destructive inspection activities included utilizing data gathering equipment such as a magnetic flux leakage (MFL) and an Ultrasonic Thickness (UT) scanning device. AST #6 was inspected on June 14, 2007 and the following observations and repair recommendations were provided by the American Petroleum Institute (API)-Certified Inspector:

1. The concrete ring wall showed minor signs of cracking. This is not affecting the structural integrity of the concrete ring wall. This should be monitored.

2. Excessive vegetation was present around the tank perimeter. Consideration should be given to removing this vegetation.

3. Minor active corrosion was present around the tank perimeter on chime area. This should be monitored.

4. One grounding device was present. Consideration should be given to installing four additional grounding devices.

5. No pressure relief systems on the inlet or outlet nozzles present. Consideration should be given to installing a pressure relief system per Specification Standards if required for this product.

6. Eight stair tread to shell welds on the spiral staircase were found to be incomplete. Consideration should be given to welding these connections.
7. Minor pitting was found to be present on the interior shell. Pits up to .068 inches deep were present. This should be monitored.

8. Seven interior suction line supports were found to be welded to the pipe. Consideration should be given to cutting these supports free from the pipe and adding proper cross members for the pipe to rest upon.

9. No product side or soil side relevant indications that came close to or exceeded .180" remaining bottom plate thickness were found.

10. Thirteen fixed roof pipe supports did not have proper weep holes present. Consideration should be given to installing a tombstone type opening at the bottom of the columns to allow a proper drainage.

11. Thirteen fixed roof column support base plates were found to be welded directly to their base plates. Consideration should be given to gouging the base plates loose and installing angle clips to prevent lateral movement.

12. The tank bottom coating was found to be peeling, blistering and disbanding. Approximately three locations per plate have the coating removed to allow for prove ups. Consideration should be given to repairing this coating.

The inspector concluded that the overall condition of AST #6 was satisfactory and that the shell plate thickness, bottom plate thickness and settlement readings are suitable for intended service and will meet API Requirements.

In July 2007, repairs of above Item Nos. 4, 6, 8, 10, 11 and 12 were completed. AST #6 was placed back in service in August 2007.

6.3.2 Costs

The inspection and above noted repairs for AST #6 were completed for an approximate total cost of $300,000.

6.3.3 Additional Measures

Above Item Nos. 1, 2, 3, 5 and 7 will be monitored at AST #6 as recommended. Both AST #5 and #6 will be monitored for leaking by static gauging tests to be conducted at least annually, if possible. Static gauging tests will be conducted by holding a known volume for as long as possible and monitoring water level in the tanks over the period. Future testing will not be API-certified.

6.4 STORM WATER DRAINAGE MODIFICATIONS (NORTH AND SOUTH SIDES)

During its years of operation the Site utilized water pollution control systems to reduce the amount of ammonia and nitrates that were discharged to an NPDES permitted outfall. Process waste streams and storm water runoff from UAN and ammonium nitrate production areas in Area A were collected in a series of lagoons/ponds located in the northern portion of the Site. This water was then concentrated in the nitrate area concentrator or Ammonia Plant area concentrator and pumped to the concentrate storage pond for use in UAN solutions blending.
When the manufacturing plant shutdown in 2001, the nitrate-impacted storm water runoff could no longer be returned to the process. This nitrate-impacted runoff was subsequently directed to and stored in the Rundown Pond and Overflow Pond located in the northeastern portion of the Site. The storage of large volumes of nitrogen-impacted water was not feasible because there was not an immediate method to dispose of the water. In 2002, plans were developed for the land application of impacted water on surrounding farm land for the beneficial use of the nitrogen. Further details of the land application program are found in Section 6.21.

Storm water runoff from the Sandstone Hill in Area A drains in two different directions; a portion of the runoff drains to the north and northwest and a portion drains to the south and southeast. When the Site was operational, this water was diverted either to the effluent system or to the contaminated water collection system.

The storm water from the Sandstone Hill continues to drain as it did when the Site was operational. The drainage to the north and northwest is impacted somewhat by surface soil impacts, but the primary impact is from groundwater seeps that daylight as surface water at several locations around the hill. This surface water flows down a naturally occurring drainage ditch to the northwest and is captured by a small earthen dam that diverts the water into an underground line. This line runs to the east northeast and discharges into the Krehbiel Pond. Other surface runoff flows down the north side of the hill and also enters the Krehbiel Pond directly by another small drainage ditch.

The storm water that flows from the Sandstone Hill to the south and southeast drains by surface flow through the area of the former Central Ponds and around the south side of the ammonium Nitrate Process Area. This storm water combines with drainage from the process area and Ammonium Nitrate Warehouse areas. Currently, this drainage can be discharged to the NPDES system or diverted to the contaminated water collection system. The general storm water flow is shown on Figure 6-2.

The system that collects the nitrate-impacted storm water in the Ammonium Nitrate Process Area consists of a series of surface drainage structures and underground drainage pipes that consolidate the runoff either to the north or the south of the process area. The water is then either pumped to or gravity drained to the Rundown Pond. Because of changes made in the operation of the Overflow Pond, the West Pond, and the proposed future closure of the West Extension Pond and the Rundown Pond, modifications were made to direct the nitrate-impacted storm water to the desired destination.

6.4.1 Interim Measures

6.4.1.1 North Drainage

During the operation of the plant, process wastewater and storm water falling on the north process area flowed through drains and entered the West Pond, moving through the West Pond and then entering the West Extension Pond. Since the plant shutdown, the storm water runoff has continued to follow this same path. Because of the proposed closing of the West Extension Pond, it was determined that the runoff needed to be directed to the Krehbiel Pond. To accomplish this, a sump, pump and piping were installed where the underground drainage lines entered the West Pond. The piping allowed for the storm water to be pumped to the land application above ground storage tanks during low flow periods and directed the storm water
through the West Pond to the Krehbiel Pond during high flow periods. From the Krehbiel Pond, the storm water is transferred into the Effluent Pond system using the Krehbiel Pond sump and pump. Further details concerning this modification can be found in Section 6.10.

6.4.1.2 South Drainage
When the Site was in operation, storm water runoff from the Sandstone Hill drained to the south and southeast and was channeled to follow drainage ditches. The drainage ditches directed the runoff either to the contaminated water collection system or to the NPDES effluent system. The water draining off the Sandstone Hill flows through the Central Ponds (which have been removed and flows to the east-southeast combining with other flows). Since the operations were shut down, the majority of this water has been diverted to the NPDES discharge. In September 2007, piping changes were made to direct this water to the Overflow Pond with the final disposition being land application. Further details concerning the piping modifications can be found in Section 6.9.

Part of the drainage to the southeast from the Sandstone Hill drained to a small pond that impounded the water near AST 5 and AST 6. There was no discharge from this pond. This pond was opened to facilitate drainage. Further details of this action are found in Section 6.2.

A significant portion of the impact to storm water draining from the Sandstone Hill is caused by groundwater seeps that come to the surface and are picked up by storm water. Other impacts are related to the dissolving of nitrogen compounds from the surface soils by the storm water. To alleviate some of the surface impacts, in 2002 clean soils were spread over the hill and grass was planted. In 2006, further clean soils were trucked to the top of the hill and spread in a layer approximately 6 inches deep. Native grasses were then planted to reduce erosion and help control runoff.

6.4.2 Costs
The costs associated with interim storm drainage modifications of the Sandstone Hill are discussed in Sections 6.2, 6.9, and 6.10. That portion of those costs discussed in those sections associated with drainage modifications at the Sandstone Hill totaled $213,991.

6.4.3 Additional Measures
Groundwater seeps continue to impact storm runoff. One way to control nitrogen impacts to groundwater from the subsurface soils is to remove the nitrogen from the subsurface soils. As a result, additional remedial measures are recommended in the area of the Sandstone Hill. A more detailed evaluation of the potential additional remedial measures for the Sandstone Hill is provided in Section 7.3.

6.5 ABANDONMENT OF SEPTIC TANK SYSTEM

A 500-gallon septic tank was located at the northwest portion of the Site in the vicinity of the Bag Warehouse (Figure 6-1). On November 21, 2006, the KDHE requested that the septic tank be located, uncovered (asphalt cover), emptied and filled with an inert material.
6.5.1 Interim Measures

In June 2007, the Bag Warehouse septic tank was located and uncovered. The tank contained water, sediments and gravel. The water and sediments were pumped-out and disposed of as domestic sludge with the City of Topeka. As discussed with the KDHE on June 7, 2007, the gravel was removed and disposed of in the East Lime Pond. Once the gravel was removed and disposed of, the empty tank and excavation was backfilled with clean soil obtained on-site and the area was restored to its original condition.

6.5.2 Costs

The scope of work associated with the interim remedial measure at the septic tank near the Bag Warehouse was completed for an approximate total cost of $12,000. The scope of work performed included the removal and disposal of water, sediments and gravel from the tank.

6.5.3 Additional Measures

No additional measures will occur at the Bag Warehouse Septic Tank as the tank has been abandoned.

6.6 REMOVED SLUDGE FROM IMHOFF TANK

The Imhoff Tank began operation in 1954 and is a component of the Site’s waste water treatment system. The tank is an approximately 39,000-gallon below grade concrete tank designed to treat domestic wastewater, sanitary wastewater sewers, and waste water pump stations. Once full, the Imhoff Tank discharges into the effluent ponds. The location of the Imhoff Tank is illustrated on the Site Map provided as Figure 6-1.

In October 2006, the contents of the Imhoff Tank (sludge and liquid) were sampled and analyzed for disposal requirements in preparation to clean-out the tank. Based on the results of the analyses, the City of Topeka agreed to accept the tank contents as domestic sludge.

6.6.1 Interim Measures

In June 2007, the Imhoff Tank was temporarily taken out of service and pumped-out including the removal of approximately 10,000 gallons of sludge and 35,000 gallons of liquids. As noted above, the sludge and liquids were disposed of as domestic sludge with the City of Topeka. The tank was returned to service upon removal of the sludge and liquids but only accepts domestic wastewater from the on-Site Laboratory and Administration Building.

6.6.2 Costs

The scope of work associated with the interim remedial measure at the Imhoff Tank was completed for an approximate total cost of $20,000. The scope of work performed included the removal and disposal of approximately 10,000 gallons of sludge and 35,000 gallons of liquids from the tank.
6.6.3 Additional Measures

During the May 16, 2007 Status Meeting, the KDHE requested that the Imhoff Tank be pumped-out and decommissioned as a part of the Area B Pond decommission activities. The KDHE also requested that the sanitary sewer lines discharging to the Imhoff Tank be flushed and plugged before the tank decommissioning efforts. Upon completion of the sanitary sewer line flushing activities, the Imhoff Tank will be sampled and the tank contents removed and disposed of. Once the tank has been decommissioned, all wastes generated from the Laboratory will be directed to a polyethylene AST and properly disposed of and the Administration Building will be closed. These activities will not be performed until the East and West Effluent Ponds are desludged. Future activities associated with the Imhoff Tank will be funded by the Administrative Trust.

6.7 ABANDONMENT OF LIME SLUDGE LINES - WEST AND EAST LIME SLUDGE PONDS

The subsurface Lime Sludge Lines were utilized to transfer lime sludge from the Cold Lime Softening Unit to the West and East Lime Ponds. Approximately 1,000 feet of Lime Sludge Lines run from the Cold Lime Softening Unit to the West Lime Pond and approximately 1,500 feet of Lime Sludge Lines run from the West Lime Pond to the East Lime Pond. The locations of the Lime Sludge Lines are illustrated on the map provided as Figure 6-3.

6.7.1 Interim Measures

During the Project Team Meeting conducted on September 14, 2007, the KDHE recommended that the Lime Sludge Lines be located, plugged and abandoned-in-place in order to provide a secure burial area during the capping of the West and East Lime Ponds and to prevent leachate and other materials from backing-up into the Lime Sludge Lines from the West and East Lime Ponds. The Lime Sludge Lines were identified and mapped in September 2007.

The process for plugging the line included locating and exposing the line at the distribution header near the West Lime Pond. This distribution header was utilized to direct flow into either the West Lime Pond or East Lime Pond. Once exposed, the pipe was cut at the location upstream of the distribution header and filled with concrete. Upon completion the soils were replaced. All site activities were documented with photographs.

Documentation of the interim measures completed was provided to KDHE in a report dated December 31, 2008.

6.7.2 Costs

The scope of work associated with the interim remedial measure of the Lime Sludge Lines will be conducted for an approximate total cost of $10,150. These activities are scheduled for completion the week of November 10, 2008 and will be funded from the Administrative Trust.
6.7.3 Additional Measures

At this time, no additional measures are anticipated to occur once the Lime Sludge Lines are plugged and abandoned.

6.8 GENERAL POND DE-WATERING THROUGH NPDES AND LAND APPLICATION

While in operation, the Northern Ponds in Area B were used to contain water of varying sources and concentrations. Two of the ponds were the East Lime Sludge Pond and the West Lime Sludge Pond. The original use of these ponds was to receive the lime sludge generated during the cold lime softening of the well water brought into the plant. Over the years of operation, the West Lime Sludge Pond also received dredged materials from the East Effluent and West Effluent Ponds. The East Lime Sludge Pond received only lime sludge during operations.

In February 2006, after the completion of the Site Characterization, it was determined that these ponds could be dewatered. The dewatering of these ponds would allow the ponds to be used for the storage of other sediments, if needed. The location of these ponds is illustrated on the Site Map provided as Figure 6-1.

6.8.1 Interim Measures

A work plan was submitted to the KDHE on February 14, 2006 outlining the procedures and analytical work to be undertaken to dewater these ponds. Subsequently, KDHE requested further analytical data be collected while pumping the water and discharging it. The additional analytical data was collected and submitted to the KDHE. KDHE gave written approval to proceed with the dewatering in April 2006.

A diesel pump was used to transfer water from the East Lime Sludge Pond to the East Effluent Pond where it was blended with storm water and discharged to the Kansas River under the existing NPDES permit. Dewatering of the East Lime Sludge Pond took place from May 4 to May 11, 2006. The diesel pump was also used to transfer the water from the West Lime Sludge Pond to the East Effluent Pond for blending and discharge. This dewatering occurred from May 11 to May 16, 2006.

An estimated 1.04 million gallons of water was removed from the two ponds. A report was provided to the KDHE on July 7, 2006 documenting the dewatering of these ponds.

Water has also been removed from the Rundown Pond and Overflow Pond as a part of the land application program. Further information on the dewatering of these ponds can be found in Section 6.21.

The interim measure performed by dewatering East and West Lime Ponds is consistent with the proposed final remedy for site. Removing the water allowed the pond volumes to be available for consolidation of sediments and soils impacted by nitrogen compounds before the proposed capping and closure of these ponds. During the interim remedial measures involving the Central Ponds, the West Pond and Krehbiel Pond, impacted sediments were placed in the East Lime Sludge Pond.
6.8.2 Costs

The scope of work performed included the pumping of approximately 1.04 million gallons of water to the effluent system. Expenditures for this activity in 2006 totaled approximately $35,000.

6.8.3 Additional Measures

Since the completion of the interim remedial measure, precipitation has fallen on these ponds and collected in the low areas. As a result, before further sediment placement or closure and capping, the water will have to be removed again. It is anticipated that the amount of water to be removed will be similar to those volumes removed during interim remedial measures.

The East Lime Sludge Pond and the West Lime Sludge Pond are proposed to be closed and capped as landfills along with the Rundown Pond. Further details on the proposed activities are discussed in Section 7.3.5.

6.9 AREA B – SEDIMENT REMOVAL, OVERFLOW POND

In an effort to commence the remediation of the high risk areas at the Site, a work plan for the decommissioning of six of the seven ponds located in Area B of the site was submitted to the KDHE on March 21, 2007. The work plan outlined the details for the decommissioning of the West Extension Pond, West Effluent Pond, East Effluent Pond, West Lime Pond, Rundown Pond, and the East Lime Pond. Activities were also proposed to be performed on the Overflow Pond but this pond was not to be decommissioned. The sediments would be removed from the Overflow Pond and the pond would placed back into operation to contain storm water runoff and groundwater impacted with nitrogen compounds for future land application.

Based on a May 16, 2007 meeting with the KDHE, it was determined that the activities proposed for the Overflow Pond could be implemented but that the overall pond decommissioning activities could not be implemented at that time. The following activities were approved for implementation with respect to the Overflow Pond:

- Excavation of accumulated sediments in the Overflow Pond down to contact with the native clay pond base;
- Placement of the excavated sediments in the Rundown Pond;
- Collection of samples from the native clay base in one location for analysis of nitrogen compounds;
- Modifying the current drainage system to route potentially impacted storm water runoff from Area A to the Overflow Pond for future land application; and
- Placing the Overflow Pond back in service to contain nitrogen-impacted storm water/groundwater for future land application.

The location of the Area B ponds is illustrated on the Site Map provided as Figure 6-1.
6.9.1 Interim Measures

Field activities to complete the approved work on the Overflow Pond commenced on August 13, 2007 and were completed on September 24, 2007. RSI, Inc. was contracted to provide the necessary heavy equipment, labor, and materials required to complete the activities. In preparation for the removal of accumulated sediments in the Overflow Pond, all water contained in the Overflow Pond was removed and contained in on-site storage for future land application.

In accordance with the approved Notice of Intent dated July 27, 2007 erosion control measures were installed before initiating the excavation activities. A total of 3,500 linear feet of silt fencing and 48 hay bales were installed as part of the erosion control measures.

Excavation of the accumulated sediments contained in the Overflow Pond was completed to the engineered depth of the pond as marked by contact with the native clay base in the pond. Sediments were removed using excavators, dozers, and front end loaders. Wet sediments were mixed, using the heavy equipment, with drier material before moving the sediments to the Rundown Pond. No stabilization agents were used for this effort.

The sediments from the Overflow Pond were directly placed into the Rundown Pond using the excavation equipment; trucking of the sediments was not required. The sediments were placed in the Rundown Pond along the entire length of the existing dike separating the Overflow Pond and the Rundown Pond and were track compacted with excavation equipment.

A survey of the accumulated sediment surface in the Overflow Pond was previously performed by LandPlan Engineering and was used as a baseline survey. LandPlan Engineering performed progress surveys during the removal of the sediments to assist in determining the volume of sediments removed and completed a final survey once all sediments were removed from the Overflow Pond. Based on the initial baseline survey and the final survey, a total volume of 15,154 cubic yards of accumulated sediments were removed from the Overflow Pond which is comparable to the original estimate of 15,000 cubic yards.

Following removal of the sediments, the bottom of the Overflow Pond was shaped to provide a flat/gently sloping grade toward the southwest corner to facilitate future water removal for land application. Laser-guided excavation equipment was used to set the bottom elevation at 814.10 +/- 0.01 feet.

As requested by the KDHE, a confirmation boring was completed in the southwest corner of the Overflow Pond to obtain samples of the native clay base for analysis of nitrogen compounds. A truck-mounted Geoprobe rig was used to advance a boring to a depth of ten feet below the surface of the pond bottom. Samples were collected in 1-foot intervals beginning at 0.5 feet below surface. The samples were analyzed by the on-site laboratory for ammonia and nitrate. The analytical results are summarized in the following table.
OVERFLOW POND NATIVE CLAY BASE SAMPLING RESULTS

<table>
<thead>
<tr>
<th>Sample ID NO.</th>
<th>Date Sampled</th>
<th>Date Extracted</th>
<th>Date Analyzed</th>
<th>Ammonia-Nitrogen (mg/kg dry wt.)</th>
<th>Nitrate/nitrite-Nitrogen (mg/kg dry wt.)</th>
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</thead>
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<td>9/19/07</td>
<td>9/19/07</td>
<td>4590</td>
<td>2030</td>
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<td>9/18/07</td>
<td>9/19/07</td>
<td>9/19/07</td>
<td>3730</td>
<td>2020</td>
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<tr>
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<td>9/18/07</td>
<td>9/19/07</td>
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<td>1360</td>
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<td>950</td>
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<td>9/18/07</td>
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<td>20</td>
<td>350</td>
</tr>
<tr>
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<td>9/19/07</td>
<td>9/19/07</td>
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<td>800</td>
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<td>9/19/07</td>
<td>21</td>
<td>350</td>
</tr>
</tbody>
</table>

Upon completion of the sediment removal activities, modifications to the current storm water drainage system were performed to route potentially impacted storm water runoff from Area A to the Overflow Pond.

A storm water collection structure that previously directed storm water runoff from the Area A drainage paths had become plugged. This storm water collection structure was cleaned and resealed with grout to ensure closure. A metal lid was bolted to the grate so that current drainage is directed to the south into the main storm water drainage ditch until such time that the storm water runoff is to be directed to the Overflow Pond. The removal of the lid and re-direction of the storm water runoff will be coordinated with the desludging of the East and West Effluent Ponds. Once the East and West Effluent Ponds are desludged, the impacted storm water runoff from the North End of the Site will be diverted to the Overflow Pond. At that time, the metal lid will be removed and the collection structure will capture the runoff and direct it to the Overflow Pond through the piping described below.

The existing pipe that extends to the southeast from the current storm water collection structure to the small drainage ditch located south of the West Effluent Pond was repaired. At the point where the existing pipe enters the small drainage ditch, approximately 450 feet of 24-inch diameter High Density Polyethylene (HDPE) piping was connected and extended through the ditch.

At the terminus of the 24-inch diameter HDPE piping, 1,050 feet of existing 24-inch diameter stainless steel pipe was connected to the HDPE piping. The connections between the HDPE and stainless steel pipe were grouted to eliminate leakage. The stainless steel pipe was extended through the southern end of the Rundown Pond to the Overflow Pond and was installed through the western dike of the Overflow Pond (in the southwest corner of the Overflow Pond). An earthen bench was constructed along the southern end of the Rundown Pond to support the piping and maintain the desired grade. An outfall structure consisting of rip rap was installed in the Overflow Pond to protect the dike from erosion.
The HDPE and stainless steel piping runs were graded to facilitate gravity drainage of storm water to the Overflow Pond. The stainless steel piping was anchored along its length to prevent movement and the HDPE piping was covered with soil to prevent floating of the pipe.

As a result of the drainage modifications, potentially impacted storm water runoff from Area A can now be directed to the Overflow Pond for future land application.

6.9.2 Costs

The scope of work associated with the removal of accumulated sediments from the Overflow Pond and modification of the current drainage system was completed for an approximate total cost of $407,400 (of which $176,491 were costs associated with drainage modifications on the Sandstone Hill presented in Section 6.4.2). The scope of work performed included the excavation of approximately 15,154 cubic yards of accumulated sediments from the Overflow Pond with placement in the Rundown Pond, grading the base of the Overflow Pond, collection of samples from the native clay base of the Overflow Pond, clearing of an existing storm water collection structure, repair of existing drainage pipe, installation of 450 feet of new HPDE drainage pipe, movement and installation of 1,050 feet of existing stainless steel drainage pipe, construction of an outfall structure in the southwest corner of the Overflow Pond, and anchoring of the HDPE and stainless steel drainage piping to prevent movement. These costs also include the activities performed in the West Pond during 2007 as discussed in Section 6.10.1.

6.9.3 Additional Measures

The immediate future use of the Overflow Pond will be to contain potentially nitrogen-impacted storm water and groundwater for future land application. Once it is no longer necessary to contain this water, the Overflow Pond can be taken out of service and decommissioned.

Decommissioning of the Overflow Pond is anticipated to include similar cover activities that will be used to decommission the other six ponds located in Area B. Details of the decommissioning activities for these ponds are discussed in Section 7.3.5.

6.10 AREA B – WEST POND 2006 AND 2007 ACTIONS

The West Pond is located north of the former Ammonium Nitrate Production Area in Area B and encompasses approximately 0.4 acres. The West Pond is approximately 300 feet in length, 75 feet wide and of unknown original depth before sedimentation. The pond intermittently contains surface runoff as a result of precipitation events but very little surface water runoff accumulates in the pond and the natural surface water flow in the pond is towards the West Extension Pond.

The West Pond was not identified for investigation during the RCRA Facility Assessment (RFA) conducted in 1990 (USEPA, September 1990), and no sampling was conducted during the Comprehensive Investigation completed in 1993-1994. However, the West Pond was investigated during the site characterization activities performed at the site from March 2005 to July 2005. Based on the results of the site characterization activities, total nitrogen contamination was limited to the pond area where total nitrogen concentrations exceeded 10,000 mg/kg. Samples collected from the West Pond had measured concentrations of ammonia from...
2,020 mg/kg to 18,000 mg/kg and total nitrogen concentrations of 3,350 mg/kg to 28,600 mg/kg. Groundwater near the West Pond was also found to contain elevated nitrogen levels.

Excavation of the sediment from within the pond area was selected as the interim remedial measure to be implemented in the West Pond. 1,900 cubic yards of nitrogen-impacted sediment were estimated to be in the West Pond. The interim remedial measure was implemented pursuant to the KDHE approved Interim Measures Work Plan dated March 8, 2006.

Subsequent measures were taken in 2007 to modify storm water runoff into and through the West Pond.

The location of the West Pond is illustrated on the Site Map provided as Figure 6-1.

6.10.1 Interim Measures

Between May 14 and June 15, 2006 nitrogen-impacted soils were excavated from the West Pond and placed in the East Lime Pond in Area B. Before relocation of the sediments, the East Lime Pond was dewatered between May 4 and May 11, 2006. Water from the East Lime Pond was discharged into the East Effluent Pond in accordance with a work plan dated March 8, 2006 and approved by KDHE on April 20, 2006.

Approximately 2,750 cubic yards of impacted sediment were removed from the West Pond by excavating to the bedrock interface at a depth of approximately 3 feet. The excavated material was direct-loaded onto trucks and transported to the East Lime Pond in Area B where it was placed in the south end of the East Lime Pond.

Approximately 2,200 cubic yards of backfill material, obtained on-site, was used to restore the surface grade to eliminate future accumulation of surface water and the resulting deposition of sediments. Backfill was placed in 6-inch lifts and track compacted with excavation equipment. The area of the West Pond was seeded with native grass in the fall of 2006.

The interim measures were completed in May and June 2006. The seeding of native vegetation was delayed until early fall 2006 to take advantage of cooler temperatures and seasonal rains to optimize germination of the native grasses. Documentation of the interim measures undertaken at the West Pond in 2006 was provided to KDHE in a report dated September 1, 2006.

In August and September 2007 piping modifications were made to reduce and re-route storm water runoff entering the West Pond. Four drain lines enter the West Pond in the southeast corner of the pond. These lines direct storm water runoff into the West Pond from areas to the south. The storm water runoff entering West Pond from these lines contains concentrations of nitrogen compounds. The concentrations of nitrogen compounds are higher during low flow periods than during high flow events.

A sump was installed in the southeast corner of the West Pond and the four drain lines were extended to allow discharge into the sump. A pump, capable of pumping 15 gallons per minute was installed in the sump to transfer the water from the sump, during low flow periods, to the aboveground storage tanks for use in the Land Application program.

Approximately 450 feet of 24-inch corrugated metal discharge pipe was connected to the sump and extended the full length of the West Pond to Krehbiel Pond. The 24-inch pipe directs flow
during high flow periods from the West Pond to Krehbiel Pond where the existing Krehbiel Pond pump transfers the water to the East Effluent Pond.

Following these modifications the only water entering the West Pond is precipitation that falls directly on the pond and the storm water runoff from areas immediately adjacent to the West Pond. This water is currently being directed to the West Extension Pond through the existing structure in place between the two ponds. Following the decommissioning of the other ponds in Area B further modifications will be made to the drainage in the area of the West Pond.

The interim remedial measures performed in the West Pond are consistent with the proposed final remedy for the site. Removing sediments containing high concentrations of total nitrogen will improve the water quality of surface water in the West Pond area. In addition, a source area for continued impacts to the shallow groundwater in the area was cost-effectively removed.

6.10.2 Costs

The 2006 scope of work associated with the implementation of the interim remedial measures in the West Pond was completed for an approximate total cost of $49,680. The scope of work included the excavation of approximately 2,750 cubic yards of impacted sediment, transportation of the excavated sediments to the East Lime Pond, backfilling/grading/compaction, seeding the area with grass, and project reporting. Costs for the 2007 activities totaled $65,827, which are included in the Overflow Pond activities discussed in Section 6.9.2.

6.10.3 Additional Measures

No significant additional measures are anticipated for the area of the West Pond. However, following the decommissioning of the other ponds in Area B, further modifications will be made to the drainage in this area. A more detailed evaluation of the potential additional remedial measures for the West Pond is provided in Section 7.3.4.

6.11 AREA B – KREHBIEL POND

The Krehbiel Pond is located northwest of the former Ammonium Nitrate Production Area and encompasses approximately 0.8 acres. Krehbiel Pond intermittently contains surface water runoff and is approximately 450 feet in length, 75 feet wide, and of unknown original depth before sedimentation.

Krehbiel Pond was not identified for investigation during the RCRA Facility Assessment (RFA) conducted in 1990 (USEPA, September 1990), and no sampling was conducted in it during the Comprehensive Investigation completed in 1993-1994. However, Krehbiel Pond was investigated during the site characterization activities performed at the site from March 2005 to July 2005.

Soil samples collected from Krehbiel Pond had reported concentrations of ammonia of 21.2 mg/kg to 718 mg/kg and total nitrogen of 377.2 mg/kg to 1,045 mg/kg. Groundwater analytical results showed that nitrate concentrations were highest near West Pond and Krehbiel Pond, ranging from 0.15 to 33,310 mg/L in the silty clay unit. Ammonia concentrations in groundwater were also highest near West Pond and Krehbiel Pond, ranging from less than 0.06 to 51,640 mg/L in the silty clay unit.
Excavation of the sediment from within the pond area was selected as the interim remedial measure to be implemented in Krehbiel Pond. 2,500 cubic yards of nitrogen-impacted sediment were estimated to be in Krehbiel Pond.

The location of Krehbiel Pond is illustrated on the Site Map provided as Figure 6-1.

### 6.11.1 Interim Measures

Between May 14 and June 15, 2006 nitrogen-impacted soils were excavated from the Krehbiel Pond and placed in the East Lime Pond in Area B. Before relocation of the sediments, the East Lime Pond was dewatered between May 4 and May 11, 2006. Water from the East Lime Pond was discharged to the East Effluent Pond in accordance with a work plan dated March 8, 2006 and approved by KDHE on April 20, 2006.

Approximately 4,200 cubic yards of impacted sediment were removed from Krehbiel Pond by excavating to a depth of 4 feet below existing grade or to bedrock, whichever came first. The excavated material was direct-loaded on to trucks and transported to the East Lime Pond in Area B of the site where it was placed in the south end of the East Lime Pond.

Approximately 2,700 cubic yards of backfill material, obtained on-site, was used to restore an adequate grade for proper surface water flow and erosion control. Backfill was placed in 6-inch lifts and track compacted with excavation equipment.

The interim measures were completed in May and June 2006. The seeding of native vegetation was delayed until early fall 2006 to take advantage of cooler temperatures and seasonal rains to optimize germination of the native grasses. Documentation of the interim measures undertaken at the Krehbiel Pond in 2006 were provided to KDHE in a report dated September 1, 2006.

Currently, surface water that accumulates, including storm water runoff directed through the West Pond to Krehbiel Pond, is transferred by the existing pump in Krehbiel Pond through piping to the East Effluent Pond.

The interim remedial measures performed in the Krehbiel Pond are consistent with the proposed final remedy for the site. Removing sediments containing high concentrations of total nitrogen will improve the water quality of surface water in the Krehbiel Pond area. In addition, a source area for continued impacts to the shallow groundwater in the area was cost-effectively removed.

### 6.11.2 Costs

The scope of work associated with the implementation of the interim remedial measures in the Krehbiel Pond was completed for an approximate total cost of $55,748. The scope of work performed included the excavation of approximately 4,200 cubic yards of impacted sediment, transportation of the excavated sediments to the East Lime Pond, backfilling/grading/compaction, seeding area with grass, and project reporting.

### 6.11.3 Additional Measures

No significant additional measures are anticipated for the area of the Krehbiel Pond. However, following the decommissioning of the other ponds in Area B, further modifications will be made to
6.12 GROUNDWATER COLLECTION PIPED TO ABOVE GROUND STORAGE TANKS

The existing groundwater collection system consists of a series of interceptor trenches (or French drains) that have been designed and engineered to collect shallow nitrogen impacted groundwater and contain it for future beneficial use. The systems were designed and installed to address specific issues at different times during the operation of the Site.

Two documents by Woodward-Clyde Consultants dated June 1975 recommended and describe the construction of two groundwater interceptor drains. One drain (South Sump) was recommended for the bottom of the Sandstone Hill near the present Krehbiel Pond. The second drain (North Sump) was recommended for the area north of the present West and West Extension Ponds along the railroad tracks. The drains were designed to prevent nitrate impacted groundwater from exiting the property toward the north. The groundwater collected in these interceptor trenches was pumped to the West Pond and West Extension Pond for recovery and reuse of the nitrogen.

Two interceptor trenches were installed in 1995 as part of secondary containment system for fertilizer storage tanks and ponds. These two trenches surrounded the Rundown Pond and Overflow Pond in Area B. The groundwater collected by these trenches (Northwest Sump and Southeast Sump) was pumped back into the ponds for recovery of the nitrogen into fertilizer product.

As a result of the Comprehensive Investigation in 1994 and Corrective Action Study in 1995, the interceptor trench along the north side of the Rundown Pond and Overflow Pond was extended to the west along and parallel to the BNSF railroad tracks along the northern property boundary and connected to the existing Northwest Sump. Another trench was installed to the east along the same line paralleling the BNSF railroad tracks. This trench was designated the Northeast Sump. These interceptor trenches were designed to intercept shallow nitrogen-impacted groundwater underlying the ponds.

Because of the proposed change in operation of the Rundown Pond and Overflow Pond, a change was made to permanently pump the discharge from the interceptor trenches directly to the AST’s. This made the water immediately available for land application for beneficial use of the nitrogen.

These interceptor trenches, as well as the collection system and Above Ground Storage Tanks (AST’s) are shown on the Site Map provided as Figure 6-1.

6.12.1 Interim Measures

Between July 24, 2006 and August 1, 2006, new discharge lines were installed starting from the interceptor trench sumps and connected to existing piping in the old process area that carries the water to the two AST’s. Approximately 4300 feet of 2-inch diameter HDPE pipe was installed to route the water from the sumps to connection with existing piping. The HDPE pipe was installed
below the frost line to keep the lines from freezing and at the sumps, where the pump discharges come above ground, the piping, meter, and valves are heat traced to prevent freezing.

New high head pumps, with the necessary pressure to pump the water the total distance, were installed in each of the interceptor trench sumps. Check valves and ball valves were installed at the discharge of the pumps to prevent backflow into the sumps and also to provide the ability to isolate each sump and pump for future maintenance. A pipe run to the Overflow Pond was installed as a contingency to maintain adequate holding capacity during peak impacted water generation periods.

The interim measure performed by re-piping the discharge of the interceptor trenches to the AST's is consistent with the proposed final remedy for site. Directing the water directly to the tanks provides efficiency in collecting the water for beneficial use. It also removes a source of water that was being placed in the Rundown Pond and Overflow Pond so that future remedial measures can move forward on these ponds.

### 6.12.2 Costs

The scope of work associated with the interim remedial measure in re-piping the discharge of the interceptor trenches to the AST's was completed for an approximate total cost of $55,200. The scope of work performed included the installation of approximately 4300 feet of HDPE pipe.

### 6.12.3 Additional Measures

This system will continue to be used to collect nitrogen-impacted groundwater for an assumed minimum period of 30 years. The system will require maintenance including cleaning of the pumps, sumps, and valves. It is conceivable that the pumps will have to be repaired or replaced during the lifetime of the system.

A more detailed evaluation of the potential future maintenance and use of this system are provided in Section 7.1.2.

### 6.13 AREA D – CATALYST LANDFILL

The Catalyst Landfill was located in the northern portion of the Operations Area (Area D) and was constructed to receive spent catalysts produced in various operations at the Site. The landfill measured approximately 150 feet by 25 feet by 15 feet deep, was unlined, and operated between 1981 and 1989 on an as-needed basis with the approval of KDHE. The landfill was covered with surrounding soils when not active and upon closure. It was identified as SWMU #5 during the RCRA Facility Assessment (USEPA, 1990).

The following compounds were present in the various catalysts disposed in the landfill: iron oxide, aluminum oxide, calcium oxide, chromium (III) oxide, chromium (VI), graphite, confidential metal oxide, copper oxide, zinc oxide. The catalyst containing hexavalent chromium was comprised of less than 0.01% chromium (VI). EP toxicity data obtained from catalysts containing chromium were found to contain <0.05 mg/L to 0.12 mg/L chromium. No documentation or evidence of releases from the catalyst landfill were reported.
The catalyst landfill was investigated during the 2005 Site Characterization activities. Surface and subsurface soil samples were collected from the vicinity of this landfill for total RCRA metals analysis. A sample of the catalyst material was retrieved and submitted for TCLP analysis.

The exact location of the Catalyst Landfill was unknown, and therefore, it was necessary to advance exploratory borings to identify the former landfill location. Once the landfill boundaries were identified, four borings were advanced around the perimeter and two borings were advanced in the waste material. Catalyst material was encountered at approximately 4 feet bgs and extended to between 6.5 feet and 8.5 feet bgs.

Six surface soil samples were collected from the Catalyst Landfill for RCRA metals analysis. Arsenic, barium, chromium and lead were detected in all six (6) surface samples. Concentrations for arsenic were reported ranging from 7.55 mg/kg to 12.3 mg/kg, and barium reported concentrations ranging from 82.3 to 203 mg/kg. Chromium concentrations were reported ranging from 16.5 mg/kg to 202 mg/kg, and lead was reported in concentrations ranging from 12.0 mg/kg to 24.0 mg/kg. Mercury, selenium and silver were not detected at concentrations above the laboratory detection limits in any of the surface soil samples.

Four subsurface soil samples were collected from the Catalyst Landfill for RCRA metals analysis. Arsenic, barium, chromium and lead were also detected in all subsurface samples. Concentrations for arsenic were reported ranging from 8.07 mg/kg to 15.7 mg/kg, and chromium was reported in concentrations ranging from 18.7 mg/kg to 98.6 mg/kg. Barium was reported in concentrations ranging from 106 mg/kg to 243 mg/kg and lead was reported in concentrations ranging from 16.1 mg/kg to 23.1 mg/kg. Mercury, selenium and silver were not detected at concentrations above the laboratory detection limits in any of the subsurface soil samples.

A sample of the buried catalyst material was obtained and submitted for TCLP analysis for RCRA metals. Analytical results were non-detect for Arsenic, Cadmium, Chromium, Lead, Selenium, Silver and Mercury. Barium was detected at 1.3 mg/L.

Excavation of the soil/catalyst material from within the landfill area was selected as the interim remedial measure to be implemented in the Catalyst Landfill.

The location of the Catalyst Landfill is illustrated on the Site Map provided as Figure 6-1.

### 6.13.1 Interim Measures

Between May 14 and June 15, 2006 approximately 815 cubic yards of catalyst material and soil was excavated from the Catalyst Landfill area. Excavated material was transported and disposed at a permitted special waste landfill. The table below presents the results of confirmation sampling of the Catalyst Landfill excavation before backfill. The excavation was backfilled with clean fill material and seeded with native grasses.
### Catalyst Landfill Excavation Sample Analysis Results

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Date Sampled</th>
<th>Location</th>
<th>Total Chromium (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T13826-1</td>
<td>6/14/06</td>
<td>Catalyst Landfill South Wall</td>
<td>44.0</td>
</tr>
<tr>
<td>T13826-2</td>
<td>6/14/06</td>
<td>Catalyst Landfill East Wall</td>
<td>39.6</td>
</tr>
<tr>
<td>T13826-3</td>
<td>6/14/06</td>
<td>Catalyst Landfill North Wall</td>
<td>19.5</td>
</tr>
<tr>
<td>T13826-4</td>
<td>6/14/06</td>
<td>Catalyst Landfill West Wall</td>
<td>16.7</td>
</tr>
<tr>
<td>T13826-5</td>
<td>6/14/06</td>
<td>Catalyst Landfill South Bottom</td>
<td>21.7</td>
</tr>
<tr>
<td>T13826-6</td>
<td>6/14/06</td>
<td>Catalyst Landfill North Bottom</td>
<td>27.3</td>
</tr>
<tr>
<td>T13826-7</td>
<td>6/14/06</td>
<td>Catalyst Landfill Duplicate (T13826-6)</td>
<td>21.9</td>
</tr>
</tbody>
</table>

The sample collected of the catalyst material during Site Characterization activities was retrieved at a depth of approximately 4 to 8 feet and found to contain total chromium at a concentration of 10,100 mg/kg. The KDHE Tier 2 Risk Based concentration for total chromium in a non-residential scenario is 390 mg/kg for the soil pathway. Sample results of the excavation area following removal of the catalyst indicate that the catalyst material has been successfully removed from the Catalyst Landfill.

Documentation of the interim measures undertaken at the Catalyst Landfill in 2006 was provided to KDHE in a report dated September 1, 2006.

The interim remedial measures performed in the Catalyst Landfill were consistent with the proposed final remedy for the Site. Removing catalyst material and soil containing high concentrations of total chromium removed a source area for potential impacts to the shallow groundwater in that area.

#### 6.13.2 Costs

The scope of work associated with the implementation of the interim remedial measures in the Catalyst Landfill was completed for an approximate total cost of $75,600. The scope of work performed included the excavation of approximately 815 cubic yards of catalyst material and soil, transportation of the excavated material off-site for disposal at a permitted special waste landfill, confirmation sampling, backfilling/grading/compaction, seeding the area with grass, and project reporting.

#### 6.13.3 Additional Measures

No additional measures are planned for the Catalyst Landfill. The interim measure implemented has successfully removed the catalyst material and soil impacted with chromium from this area. As referenced in Section 5.1.4, the Catalyst Landfill is recommended for no further action status.

#### 6.14 AREA D – SPILL POND AND OIL POND

The Spill Pond is located in the southeastern portion of the Site and was constructed to contain potential spills from the unloading of fuel oil which was used as a backup fuel source. The use of fuel oil ended in 1979, after which no shipments of fuel oil were received. This pond was
identified by USEPA as SWMU #16 during the facility assessment conducted in 1990, and visible evidence of past spills or releases into the pond was reported.

The Spill Pond was unlined and measured approximately 200 feet by 25 feet by 4 feet deep. The pond contained approximately 2 feet of water when the facility was in operation. This area was investigated during the Comprehensive Investigation completed in 1993-1994.

The Oil Pond is also located in the southeastern portion of the Site. The Oil Pond measures 30 feet by 40 feet by 2 feet deep and is enclosed by a 3-foot high earthen berm on three sides. The pond was formerly used for annual fire training exercises. Waste oil was used as the flammable medium for the exercises. Releases of oil to the ground and overflow of oil during rain events were observed by USEPA during the facility assessment in 1990, and this pond was identified by USEPA as SWMU #17. Surface runoff from the Oil Pond flows to an adjacent ditch which eventually discharges to the Effluent Ponds at the north end of the facility. This area was investigated during the Comprehensive Investigation completed in 1993-1994.

The Spill Pond and Oil Pond were also further investigated during the site characterization activities performed at the Site from March 2005 to July 2005. Concentrations of residual petroleum hydrocarbons detected in these ponds during the site characterization activities were below the KDHE risk-based non-residential use levels. Therefore, the selected interim remedial measure to be implemented in these ponds was to cover the area of the ponds with clean soil, grade to prevent ponding, and seed with native grasses.

The location of the Spill Pond and Oil Pond is illustrated on the Site Map provided as Figure 6-1.

### 6.14.1 Interim Measures

Between May 10 and June 15, 2006 the selected interim remedial measure was implemented in the area of the Spill Pond and Oil Pond.

The Spill Pond contained approximately 12-inches of water from precipitation events and it was determined the pond would require dewatering. A pump was used to dewater the Spill Pond over the period from May 10 to May 15, 2006. The water was directed to the main storm water ditch that flows through the Site and enters the Effluent Pond system. Approximately 25,000 gallons of water was removed from the Spill Pond. Once the Spill Pond was dewatered, approximately 2,000 cubic yards of on-site fill material was used to restore surface grade for the Spill and Oil Ponds. The areas were then seeded with native grasses.

Documentation of the interim measures undertaken at the Spill and Oil Ponds in 2006 was provided to KDHE in a report dated September 1, 2006.

### 6.14.2 Costs

The scope of work associated with the implementation of the interim remedial measures in the Spill and Oil Ponds was completed for an approximate total cost of $12,700. The scope of work performed included the dewatering of approximately 25,000 gallons of water from the Spill Pond, backfilling/grading/compaction of approximately 2,000 cubic yards of fill material in the area of the Spill and Oil Ponds, seeding the areas with grass, and project reporting.
6.14.3 Additional Measures

No additional measures are planned for the Spill and Oil Ponds.

6.15 CRS UNIT

A chromium reduction system (CRS) surface impoundment was operated at the Site from 1972 to 1984. The CRS was constructed and operated to remove hexavalent chromium from water, which had been circulated through cooling towers to inhibit corrosion. The CRS operated by reducing soluble hexavalent chromium to insoluble trivalent chromium using sulfur dioxide and allowing the product to precipitate out of the water before release of the water to surface discharge under a NPDES permit. The system consisted of an unlined ditch, surface impoundment, lined caustic and acid water ponds and a sulfur dioxide storage building. Use of the CRS was discontinued in 1984 when Farmland changed to a phosphate-based corrosion inhibitor for its cooling towers. Because the CRS Unit is subject to the provisions of RCRA, the KDHE Bureau of Waste Management has maintained regulatory oversight independent of the remainder of the Site. The location of the CRS Unit is illustrated on the Site Map provided as Figure 6-1.

Closure of the CRS was accomplished in 1986 and early 1987 under a RCRA Closure Plan approved by the KDHE. The acid and caustic ponds were also closed in 1987 with removal of pond liners, backfilling of the depressions and capping with native soils. A groundwater interceptor trench with a French drain was installed in 1986.

6.15.1 RCRA Closure

The CRS surface impoundment area consisted of a 360-ft drainage ditch and a 20-ft to 60-ft wide by 80-ft long holding pond. Because the treatment process was no longer being used at the time of closure (1986), the CRS system was closed as a surface storage impoundment. A Closure Project Certification Report was prepared by Geraghty & Miller, Inc. in January 1987.

Closure activities included:

- Sampling and analysis of the soil in the surface impoundment area ditch and pond.
- Sampling and analysis of the Petromat liner along the side of the pond.
- Removal and disposal of contaminated soil at a hazardous waste disposal facility.
- Petromat liner removal and disposal as non-hazardous waste.
- Construction of an interception trench (French drain) east of the pond and ditch to accelerate removal of contaminated groundwater.

6.15.2 Investigation and Removal Action

Water from cooling towers entered the CRS unit through an unlined ditch. The CRS pond was unlined on the bottom and lined with Petromat liners on the sides. Twelve composite soil samples were collected from the drainage ditch area. In addition, 18 composite soil samples and
four samples of the Petromat liner were collected from the pond area. All samples were analyzed for total chromium and 12 samples were analyzed for EP toxicity.

Results of the total chromium and EP toxicity soil samples analyses showed that chromium concentrations exceeded the action limit of 32 mg/kg, requiring removal of all soil in the ditch bottom down to the underlying sandstone. In the pond area, chromium results indicated that partial soil removal was necessary in 75% of the sampled area. EP toxicity results showed the extractable chromium concentrations to be below the action level of 5 mg/kg.

A total of 11 groundwater monitoring wells were installed between 1983 and 1985 around the CRS Unit and drainage ditch before closure activities. Drilling logs for the wells indicated the presence of silt and clay overburden of variable thickness overlying shale or sandstone bedrock. A second shale unit was observed beneath the sandstone unit. Hydraulic conductivity data collected from the monitoring wells indicated highly variable conditions ranging from $2 \times 10^{-6}$ centimeters per second (cm/sec) to $4 \times 10^{-3}$ cm/sec.

A total of 496 cubic yards of soil were removed from the ditch (272 cubic yards) and pond (224 cubic yards) areas. Depth of removal from the ditch was 24 inches from the sides and floor. Depth of removal from the pond ranged from zero to 24 inches from the sides. Most of the pond bottom was sandstone. All soil was transported to the Peoria Disposal Company site in Illinois. The Petromat liner removed from the pond was found to be non-hazardous and did not require disposal as a hazardous waste.

As noted above, an interceptor trench (French drain) was installed to intercept the flow and accelerate the removal of shallow groundwater in the area of the CRS Unit. The drain was installed in the upper surface of weathered sandstone. The depth of the trench was approximately 6 ft at the south end and 15 ft at the north end. A sump was installed near the north end of the French drain to supplement withdrawal of water from the system. The outfall of the drain is in the drainage ditch northeast of the pond area.

### 6.15.3 Post-Closure Activities

The CRS Unit was unable to receive clean-closed status because chromium was detected at concentrations above acceptable limits in the groundwater beneath the Site. Therefore, a Part B Post Closure Care Permit Application was submitted to the KDHE and USEPA Region VII in January 1988. A RCRA permit for post closure care, valid for 10 years, was jointly issued by the KDHE and USEPA Region VII in February 1993. In August 2002, an application for renewal was submitted to the KDHE with the intent of continuing the post closure care and monitoring. The CRS unit operates under USEPA ID #KSD007128507.

The scope of the Post Closure Care Permit included corrective action and monitoring of the groundwater beneath the CRS Unit for both chromium concentrations and pH. Since the corrective action and monitoring was implemented, the chromium concentrations in groundwater declined to below the action level. However, the pH of the groundwater is still below the acceptable range in three wells and in the French drain discharge. The CRS area continues to be subject to post-closure monitoring pending return of pH conditions in the groundwater to near neutral (between pH of 6 and 9).
6.15.4 Groundwater Monitoring and Additional Soil Investigation

Groundwater monitoring and reporting have been conducted at the CRS Unit since 1982. The Post Closure Care Permit was issued in 1993 and renewed in 2002. The Post Closure Care Monitoring Plan identifies twelve monitoring points (eleven wells and the interceptor trench), as detailed in the table below:

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Well Type</th>
<th>Gradient Type</th>
<th>Position</th>
<th>Screened Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW-1</td>
<td>Supplemental</td>
<td>Lateral</td>
<td>1'</td>
<td>clay; 3' sandstone; 6' shale</td>
</tr>
<tr>
<td>MW-2</td>
<td>Compliance</td>
<td>Down</td>
<td>2'</td>
<td>sandstone; 8' shale</td>
</tr>
<tr>
<td>MW-3</td>
<td>Compliance</td>
<td>Down</td>
<td>4'</td>
<td>sandstone; 6' shale</td>
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<tr>
<td>MW-4</td>
<td>Supplemental</td>
<td>Up</td>
<td>6'</td>
<td>sandstone; 4' shale</td>
</tr>
<tr>
<td>MW-5</td>
<td>Supplemental</td>
<td>Up</td>
<td>6'</td>
<td>sandstone/shale; 4' shale</td>
</tr>
<tr>
<td>MW-6</td>
<td>Supplemental</td>
<td>Down</td>
<td>4.5'</td>
<td>clay; 5.5' sandstone</td>
</tr>
<tr>
<td>MW-7</td>
<td>Supplemental</td>
<td>Down</td>
<td>5.5'</td>
<td>clay; 4.5' sandstone</td>
</tr>
<tr>
<td>MW-8</td>
<td>Supplemental</td>
<td>Down</td>
<td>10'</td>
<td>shale</td>
</tr>
<tr>
<td>MW-9</td>
<td>Supplemental</td>
<td>Down</td>
<td>5'</td>
<td>silty clay; 1.5' sandstone; 3.5' shale</td>
</tr>
<tr>
<td>MW-10</td>
<td>Supplemental</td>
<td>Down</td>
<td>(dry)</td>
<td></td>
</tr>
<tr>
<td>MW-11</td>
<td>Supplemental</td>
<td>Lateral</td>
<td>2'</td>
<td>silty clay</td>
</tr>
<tr>
<td>Trench</td>
<td>Compliance</td>
<td>Down</td>
<td></td>
<td>unconsolidated overburden</td>
</tr>
</tbody>
</table>

An additional monitoring well was installed in 2005 (MW-12) to provide groundwater information in the area immediately down gradient of the former acid water pond and has been included in the post-closure monitoring program. In addition to quarterly sampling, pH is typically measured in key wells on a monthly basis.

A subsurface soil pH investigation was performed in 2005 to provide better definition of soil conditions in the acid pond and areas down gradient and obtain geotechnical data for overburden sediments. Results were reported to the KDHE in November 2005 and indicated the bulk of low pH soils is located west of the drainage ditch.

During the field investigation, no groundwater was found above the soil-bedrock interface. However, previous investigations at the site concluded that two water-bearing zones may exist in the subsurface. The primary water-bearing zone is the sandstone unit, which is up to 15 ft thick at the southern end of the CRS Unit and is thinner and deeper at the northern end. The floor of the upstream ditch associated with the CRS Unit is in direct contact with the sandstone unit in some places. A secondary, discontinuous perched water-bearing system is present above the clay or shale unit that overlies the sandstone.

6.15.5 Interim Measures

As groundwater pH is the only remaining compliance issue for the CRS Unit and as chromium has not been detected in the monitoring wells, FI Kansas Remediation Trust and the KDHE have concurred that the CRS Unit may be clean-closed following rectification of the low pH condition.
To help mitigate the low pH condition, a potable water injection system was constructed and operated to allow potable water to flow under natural hydraulic gradient though the CRS Unit subsurface in an effort to accelerate the mitigation of low pH conditions and also to increase the hydraulic gradient through the site. Potable water was used to minimize construction, operation, and maintenance costs and to eliminate the risk of producing adverse conditions or chemical reactions in the subsurface.

A work plan describing the conceptual design of the injection system was submitted to the KDHE in June 2005. The system consisted of two rows of injection wells along the western and southern edges of the former acid pond in order to feed water to the bedrock system. The system also consisted of an infiltration trench in the same location to allow water to flow into overburden silts and clays.

A permit for injection of potable water was issued by the KDHE on March 20, 2006. The potable water injection system began operation on May 1, 2006. The amount of potable water introduced by gravity flow to the infiltration system was approximately 100,000 gallons per month. The system was monitored daily, and pH measurements were recorded weekly.

An amendment to the potable water injection system was installed in June 2007. The amended system involved injection of a sodium bicarbonate solution into the potable water stream before distribution to the infiltration trench and injection wells. An additional injection well was also added in a position immediately south of the former chromium destruct pond in an effort to facilitate distribution of the bicarbonate solution. Sodium bicarbonate has the effect of neutralizing the acidic groundwater more rapidly than straight potable water.

The pH monitoring data accumulated since start up of the injection system in 2006 has not shown significant adjustment back to neutral conditions, likely because of the low hydraulic conductivity of the water bearing zones. The estimated flow rate of groundwater through the CRS Unit was calculated during the closure investigation to be approximately 20 ft per year on average under natural hydraulic gradient conditions. The area of low pH groundwater is approximately 240 feet long.

To speed the recovery of groundwater pH to near neutral conditions, alternative options for in-situ and/or ex-situ pH adjustment and/or increasing hydraulic conductivity have been evaluated and are presented in the Interim Remedial Measure Plan for the CRS Unit. The Plan includes a description and estimated costs for the following accelerated remedial options:

- Groundwater Recirculation;
- Direct Injection of Neutralizing Agent;
- Excavation and Neutralization; and
- Injection of 5% Sodium Bicarbonate.

On December 28, 2007, the Plan was submitted to the KDHE for review. A copy of the Plan is provided in Appendix C.

In correspondence dated February 19, 2008 KDHE requested that a petition be prepared to suspend all Post-Closure Care and monitoring requirements on the CRS unit based on a successful clean-up of groundwater for submittal to the KDHE/Bureau of Waste Management.
On March 14, 2008 a petition was submitted to KDHE to suspend all Post-Closure Care and monitoring requirements on the CRS unit.

Subsequently, on May 1, 2008, KDHE requested cost estimates to restart the groundwater injection system at the CRS unit. On May 16, 2008 cost estimates for restarting the groundwater injection system were submitted to KDHE.

As a response from KDHE on the May 14, 2008 petition to suspend all Post-Closure Care and monitoring requirements for the CRS or the subsequent May 16, 2008 estimates to restart the groundwater injection system had not been received, on October 1, 2008 a request for a final determination on the petition was submitted to KDHE. Included with this request was a proposal that if the petition could not be approved, the monitoring requirements for the CRS unit be reduced. The following reductions were proposed:

- Reduce monitoring from quarterly to semi-annual events on all wells and the French drain discharge with analysis for pH only;
- Reduce reporting requirements to annual reporting only;
- Termination of the underground injection control permit and all associated monitoring and reporting;
- Discontinue the automatic pumping of selected monitoring wells; and
- A waiver of the annual Post-Closure Care permit fee from the remainder of the permit period.

On October 17, 2008 KDHE responded indicating that the petition to suspend all Post-Closure Care monitoring requirements could not be approved. A reduction in the monitoring requirements was approved including the following:

- Pumping of selected wells can be discontinued;
- Termination of the UIC permit;
- Reduction of monitoring from quarterly to semi-annual on all wells and the French drain discharge with analysis of pH only.
- Reporting requirements would remain semi-annual coupled with the annual report. However, the semi-annual reports could be reduced to include data only.

It was indicated that the annual Post-Closure Care permit fee could not be waived.

6.15.6 Costs

The scope of work associated with the implementation of the interim remedial measures at the CRS Unit was completed for an approximate total cost of $45,000. The scope of work performed included the construction and monitoring of the potable water and sodium bicarbonate injection systems.
6.15.7 Additional Measures

The additional measures planned for the CRS unit include the reduced monitoring requirements for an estimated period of 12 years. The estimated costs to complete the reduced monitoring are $8,000 annually plus the annual Post-Closure Care permit fee of $10,000.

6.16 AREA-WIDE GROUNDWATER SYSTEM

There are several groundwater monitoring and containment systems in place on the Site. Their origins and purposes derive from several different studies that have been discussed in Section 3.2. The systems are used for the management of four different groundwater units on the Site. Three of the groundwater units are not considered to have the potential to provide sustainable yields. These are the overburden unit, the bedrock unit, and the silty clay unit underlying the ponds in the northeast portion of the Site. The only aquifer that is considered to have potential for beneficial use is the Kansas River alluvial aquifer that borders on the north edge of the Site.

CRS Groundwater Remediation and Monitoring

The CRS unit was operational until 1984 in the south end of the Site, in Area D. Monitoring wells were installed to monitor the overburden and bedrock groundwater units in the vicinity of the CRS unit. The monitoring of the groundwater indicated an impact from chromium and low pH.

When the CRS unit was closed in 1986, a small interceptor trench was installed to contain the chromium impacted and low pH groundwater. The interceptor trench continues to capture impacted groundwater and three of the monitoring wells are periodically pumped to remove impacted groundwater. All the monitoring wells are sampled and analyzed on a quarterly basis with the data being submitted to KDHE. A more detailed description of the CRS unit and remedial measures within the unit is found in Section 6.15.

North End Shallow Groundwater

In the mid 1970’s Woodward-McMaster and subsequently Woodward-Clyde investigated potential impacts to the groundwater at the north end of the Site. This area is now known as Area A. These reports are discussed further in Section 3.2. As a result of these investigations two interceptor trenches were installed. The first being installed in a groundwater unit at the bottom of the Sandstone Hill just to the south of the Krehbiel Pond and the other installed north of the present West and West Extension Ponds along the north side of the in-plant railroad tracks.

Groundwater originating in the bedrock and overburden units is the source of the water removed by these interceptor trenches.

These trenches consist of 36-inch vitrified clay tile pipe with riser sumps in the middle of each trench. These trenches were refurbished in 1998. The discharge from these sumps was directed to the West Pond and West Extension Pond. This allowed for the collection of the impacted groundwater and recovery of the nitrogen to be used in the fertilizer product. In 2006 the discharge was piped directly to the above ground storage tanks as discussed in Section 6.12. The groundwater removed from these interceptor trenches is monitored and analyzed quarterly with the data being submitted to KDHE.
Two additional interceptor trenches were installed in 1995 as part of secondary containment system for fertilizer storage tanks and ponds. These two trenches surrounded the Rundown Pond and Overflow Pond in Area B and were installed in the clayey layer below the ponds. Seepage from these ponds is considered to be the source of the groundwater present in the clay and is removed by these interceptor trenches.

The groundwater collected by these trenches (Northwest Sump and Southeast Sump) was pumped back into the ponds for recovery of the nitrogen. As a result of the Comprehensive Investigation in 1994 and Corrective Action Study in 1995, the interceptor trench along the north side of the Rundown Pond and Overflow Pond was extended to the west along and parallel to the BNSF railroad tracks along the northern property boundary and connected to the existing Northwest Sump. Another trench was installed to the east along the same line paralleling the BNSF railroad tracks. This trench was designated the Northeast Sump. These interceptor trenches were designed to intercept shallow nitrogen-impacted groundwater underlying the ponds. In 2006 the discharge was piped directly to the above ground storage tanks as discussed in Section 6.12. The groundwater removed from these interceptor trenches is monitored and analyzed quarterly with the data being submitted to KDHE.

**Alluvial Aquifer System**

The Kansas River alluvial aquifer lies to the north of the Site with its southern edge along the north Site property line and underlying the northern edge of Areas A and B. This aquifer was investigated during the Comprehensive Investigation in 1995, with additional sampling conducted in 2006. During the initial investigation, it was determined that there was impact to the aquifer from nitrogen compounds. The Corrective Action Study in 1995 indicated that the impact to this aquifer could be controlled by pumping the aquifer to keep the nitrogen from exiting the Site.

Pumping of the alluvial aquifer was started in February 1998 with the pumping of well PSW-6B, augmented in 2001 with the pumping of well PSW-3B and again in 2002 with the pumping of well PSW-7B. These three wells pump water from the alluvial aquifer and discharge it to the Kansas River through the KDHE issued NPDES permit. The discharge from these wells is monitored and analyzed quarterly with the data being submitted to KDHE.

The removal of groundwater is governed by the Kansas Department of Agriculture, Division of Water Resources (DWR). In 1995, a term permit for remediation purposes was applied for to cover the interceptor trenches around the Rundown Pond and Overflow Pond. This permit (# 979045) was issued in June 1997. An application for another term permit was submitted in 1996. This permit application covered the diversion structures that were to be installed or reworked as required by the Corrective Action Study. This permit application covered the northeast interceptor trench, the north interceptor trench, the south interceptor trench and three alluvial wells. This permit was issued in 1996.

The alluvial groundwater pumping system, interceptor trenches, and monitoring network is discussed in more detail in Section 7.1.1.

**Evaluation of Groundwater Monitoring Wells**

In support of recommendations made at the completion of site characterization activities in 2006, it was concluded that it was advisable to evaluate the monitoring well network that had been
installed at this Site over the previous 30 years, determine the condition of all wells, and make recommendations as to which wells should be maintained as representative monitoring points and which wells should be plugged and abandoned. A total of 115 wells were identified from facility records, with 92 wells confirmed visually during a site inspection.

A work plan for abandonment, replacement, and rehabilitation of monitoring wells at the Site was submitted to KDHE on December 9, 2006. The plan was approved by KDHE, and field activities began in January 2007. In summary, the following activities were completed:

- Abandonment of 57 monitoring wells
- Installation of five new monitoring wells
- Repair and rehabilitation of six wells
- Grouting of one 20-foot stainless steel pipe running through the south berm of the Rundown Pond

A report of the improvements made to the monitoring well network were provided to KDHE in a report dated May 11, 2006.

6.16.1 Interim Measures

The groundwater systems at the Site will continue to be operated for a minimum period of 30 years to control groundwater containing nitrogen compounds and prevent off-site migration.

The groundwater systems are monitored quarterly. The quarterly monitoring includes collecting water level measurements, purging of the monitoring wells and collecting groundwater samples from the wells. Analytical procedures are specific for the groundwater unit and the analytes of interest within that unit. Groundwater from the CRS unit in Area D was analyzed for total chromium and pH. For the groundwater units in Areas A and B, the analytes of interest are ammonia-nitrogen and nitrate-nitrogen.

The analytical data is evaluated and performance reports are generated and submitted to the KDHE. For the CRS unit in Area D, the data was submitted monthly with a more detailed review submitted semi-annually. The data generated from the groundwater units in Areas A and B is submitted in a Performance Evaluation Report quarterly to the KDHE.

Because of the nature of the water being pumped and monitored, there are maintenance items that must be conducted on a routine schedule. This includes cleaning of the wells, pumps and discharge piping. It also includes the maintenance of the meters and other equipment.

6.16.2 Costs

During the period from May 1, 2004 through December 31, 2007 (3.5 years) a total of $211,176 was incurred in the performance of the scope of work associated with the quarterly sampling, maintenance, and reporting of the area-wide groundwater containment system. A summary of these actual costs is provided in the following table:
### Remedial Action Plan  
May 22, 2009  
Former Farmland Nitrogen Plant  
Lawrence, Kansas

<table>
<thead>
<tr>
<th>Period of Performance</th>
<th>Cost Category</th>
<th>Groundwater Containment System</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/01/04 through 04/30/05</td>
<td>Labor</td>
<td>$24,096</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$14,289</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$38,385</td>
</tr>
<tr>
<td>05/01/05 through 06/30/06</td>
<td>Labor</td>
<td>$19,277</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$45,379</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$64,656</td>
</tr>
<tr>
<td>07/01/06 through 12/31/07</td>
<td>Labor</td>
<td>$40,947</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$67,188</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$108,135</td>
</tr>
<tr>
<td>TOTALS</td>
<td>Labor</td>
<td>$84,320</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$126,856</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>$211,176</td>
</tr>
</tbody>
</table>

### Major expenses incurred in association with the groundwater trench and recovery well system during the July 1, 2006 through December 31 2007 period included the following items:

- $14,454 in electrical usage has been estimated for operation of the pumps associated with the trenches and recovery wells. Electrical usage for these pumps is not metered separately, and appears on the electrical bill for the entire site. Electrical usage over this period was estimated based on pump size and estimated hours of operation using the current electrical fee of $0.071/kilowatt-hour.
- $19,958 was incurred in association with the acid cleaning/refurbishing of the three existing recovery wells, and $3,873 was incurred for the replacement of pumps in two of the wells.
- $28,699 was incurred in association with the replacement of the HDPE discharge piping from the recovery wells to the effluent by-pass ditch. The lines were replaced as a result of fouling of the lines to the point they had become sufficiently blocked to inhibit flow through the lines. During the installation of the new lines, cleanouts were installed to facilitate future cleaning of the lines on a periodic basis.

An additional one-time expense of $155,000 was incurred during 2007 for the installation (replacement) of five (5) monitoring wells, the abandonment of 57 monitoring wells, the repair/rehabilitation of six (6) monitoring wells, and the grouting of a 20-foot stainless steel pipe running through the south berm of the Rundown Pond.

Costs for the operation and maintenance of the area-wide groundwater containment system for calendar year 2008 are estimated to be approximately $62,421. In addition, an estimated $22,490 in one time expenses for repairs to the lines from the recovery trench sumps to the ASTs and modifications to the piping to allow simultaneous pumping from the trenches and ponds to the ASTs will be incurred during calendar year 2008.
6.16.3 Additional Measures

It is recommended that operation and maintenance of the area-wide groundwater containment system be continued until groundwater is remediated to acceptable cleanup levels, which is assumed to be for a minimum period of 30 years. The annual operation and maintenance costs over this 30-year period are estimated at $70,400. Further details on the future operation and maintenance costs of the area-wide groundwater containment system are provided in Section 7.1.1.4.

6.17 STORM WATER MANAGEMENT AND MONITORING PROGRAM

Storm water management and monitoring was an important aspect during the time the Site was operational. Storm water management and monitoring was the primary method of controlling the amount of nitrogen compounds discharged through the NPDES permitted outfall. As the NPDES permits became more restrictive, the management of storm water became more important.

In 2000 and 2001, a storm water monitoring plan was developed and implemented at the direction of the KDHE. This effort resulted in a clearer understanding of the impact of soils and sediments on the storm water runoff of the Site. Data collected in 2000 and 2001 indicated that nitrogen compounds do not significantly impact the storm runoff that is generated from the south area of the plant. The data indicates that the only Site area where storm water has been shown to have been impacted significantly by nitrogen compounds is Area A or the north end of the Site. This area continues to impact the storm water, and is the area where management of the storm water is of greatest concern.

The Storm Water Management and Monitoring Program (SMMP) includes the entire Site. The purpose of the SMMP is to evaluate the existing storm water system, determine major areas of the facility that impact storm water with respect to nitrogen compounds, and to identify storm water event monitoring points.

The goal of the SMMP is:

1. minimize the contact of storm water with nitrogen impacted areas of the facility,
2. maximize the direct discharge of storm water during storm events to the Kansas River, and
3. identify the storm water monitoring points that will be sampled during precipitation events to monitor nitrogen compound concentrations on site with respect to NPDES permit requirements.

In July 2006, a Storm Water Management Plan (SMP) was submitted to the KDHE. The plan outlined the measures that have been taken or will be taken to minimize the nitrogen impact to storm water from impacted sediments and soils at the Site, and details the sampling program used to monitor the quality of storm water flowing from the various areas of the Site.
6.17.1 Interim Measures

Storm water monitoring has continued since the submittal of the SMP in 2006. There were modifications to the sampling point network as data was evaluated. The most recent sampling point network is shown on Figure 6-2.

The data continues to indicate that the south end of the Site, as well as the Areas B, E, and F do not have a significant impact on the storm water runoff concentrations. The data indicates that the ammonia-nitrogen concentrations range from <1.0 mg/L to approximately 61 mg/L. The average ammonia-nitrogen concentration over the last two years has been <10 mg/L. The nitrate-nitrogen concentrations range from 4.5 mg/L to approximately 30 mg/L, with average concentrations over the last two years being approximately 14 mg/L.

The only Site area where storm water has been shown to have been impacted significantly by nitrogen compounds is Area A. This area continues to impact the storm water, and is the area where management of the storm water is of greatest concern. Data indicates that storm water flowing from this area can range from less than 100 mg/L nitrate-nitrogen to greater than 1,000 mg/L nitrate-nitrogen. This range depends on several conditions and factors:

- the specific area within the larger general area,
- the intensity and duration of the rain event,
- the frequency of the rain events, and
- the path the runoff takes leaving the area.

Interim remedial measures were recommended in the 2006 SMP addressing areas in Area A where the shallow surface nitrogen concentrations were greatest. Some of these measures have been implemented and are discussed in some more detail in Section 6.4. Others have not been implemented because the remedial action would have minimal benefit for the costs involved.

6.17.2 Costs

The scope of work associated with the continued implementation of the storm water monitoring at the Site is estimated at $21,800 per year. This scope of work includes the sampling of storm water runoff during storm events, analysis of the samples, and reporting and evaluation of the data. This typically occurs approximately 20 times per year. It is assumed storm water monitoring will be required for a period of approximately 8 years until the East and West Effluent Ponds are desludged and the new storm water drainage ditch is constructed.

6.17.3 Additional Measures

The continued monitoring of storm water runoff is essential to the evaluation of the effectiveness of the remedial actions being completed on the Site. The data generated will also determine the need for future remedial actions. Recommendations for enhancement of the groundwater monitoring and containment system are discussed in more detail in Section 7.1.1.3.
6.18 CUT AND BLIND WATER DISTRIBUTION LINES

A series of transite water distribution lines exist in the northern and southern portions of the Site. One 14-inch transite water distribution line was utilized to transport well water to the Site from well fields located immediately east. The 14-inch line is currently not in service. In addition, one 4-inch transite line and one 8-inch transite line were utilized to transport domestic water from the City of Lawrence water distribution system to the Site. The 4-inch line is currently providing domestic water to the Site. The 8-inch line is not in service. These domestic water lines enter the Site from the west. The location of the water distribution lines are illustrated on the maps provided as Figure 6-3 and Figure 6-4.

6.18.1 Interim Measures

During the Project Team Meeting conducted on September 14, 2007, the KDHE recommended that the out-of-service water distribution lines (8-inch and 14-inch) be located and capped in order to protect the City of Lawrence and off-Site well field water supplies. The water distribution lines were identified and mapped in September 2007.

The 14-inch water line was located and exposed in the well-field up-stream of the Site and where it surfaces near the Cold Lime Softening Plant. Once exposed, the pipe was blinded at each exposed location utilizing a metal flange. Upon completion, the soil was replaced.

Documentation of the interim measures completed was provided to KDHE in a report dated December 31, 2008.

If the production wells are not sold with the Site or sold to another party, the wells will be properly plugged and abandoned.

6.18.2 Costs

The scope of work associated with conducting the above capping activities at the 8-inch and 14-inch water distribution lines was completed in November 2008 for an approximate total cost of $12,150. The capping of the water distribution lines were funded from the Administrative Trust. Costs associated with the potential plugging and abandonment of the Site production water wells is estimated at $5,200 per well. Plugging of these wells is currently not planned and will only be performed if the wells are not sold.

6.18.3 Additional Measures

At this time, no additional measures are anticipated to occur as the water distribution lines are capped. However, if the production wells are not sold with the Site or sold to another party, the wells will need to be properly plugged and abandoned.
### 6.19 IDENTIFY AND FLUSH MAJOR SUBSURFACE PIPELINES

Several subsurface sewer and major industrial pipelines exist at the Site including the following:

<table>
<thead>
<tr>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer</td>
<td>Transporting liquids from the Site restroom facilities and laboratory to the Imhoff Tank.</td>
</tr>
<tr>
<td>Storm Sewer</td>
<td>Transporting rain water from the drops located throughout the Site to the surface water ditches.</td>
</tr>
<tr>
<td>Industrial Lines</td>
<td>Primary process lines that transported concentrated ammonium nitrate and urea process water between the north and south areas of the Site.</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>Transported treated water (chlorine, bromine, phosphorous and/or chrome compounds) from the cooling towers to various locations within the Ammonia, Nitric Acid and Urea Plants and returned.</td>
</tr>
<tr>
<td>Lime Sludge</td>
<td>Transporting lime sludge from the cold lime softening units to the West and East Lime Ponds.</td>
</tr>
<tr>
<td>AST Supply</td>
<td>Transporting water from the Rundown and Overflow Ponds to ASTs #5 and #6.</td>
</tr>
<tr>
<td>Water Distribution</td>
<td>Transported well water to the Site from off-Site well fields and domestic water from the public water supply.</td>
</tr>
</tbody>
</table>

On May 16, 2007, the KDHE indicated concerns regarding the above pipelines’ impact on the Site’s environmental condition and remedial activities. The KDHE requested that the above lines be identified and considered for flushing, capping and/or abandonment.

The locations of the above pipelines are illustrated on the maps provided as **Figure 6-3**, **Figure 6-4**, and **Figure 6-5**.
6.19.1 Interim Measures

During the Project Team Meeting conducted on September 14, 2007, the following actions were identified for the subject pipelines:

<table>
<thead>
<tr>
<th>Description</th>
<th>Agreed Interim Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer</td>
<td>Flush all sanitary sewer lines into the Imhoff Tank. Plug all manholes and cap the inlet and discharge at the Imhoff Tank.</td>
</tr>
<tr>
<td>Storm Sewer</td>
<td>No action, the storm sewer lines are flushed during rain events.</td>
</tr>
<tr>
<td>Industrial Lines</td>
<td>Conduct a controlled flushing of the industrial lines that transported concentrated ammonium nitrate and urea process water between the north and south areas of the Site.</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>No action, these lines contain water treated with low levels of non-hazardous compounds. In addition, many lines are open at the surface and are filled with rain water.</td>
</tr>
<tr>
<td>Lime Sludge</td>
<td>Plug and abandon the lime sludge lines at the discharge to the West and East Lime Ponds.</td>
</tr>
<tr>
<td>AST Supply</td>
<td>No action as this line must remain in service in order to support groundwater and surface water mitigation activities.</td>
</tr>
<tr>
<td>Water Distribution</td>
<td>Cap the water distribution lines where the lines enter the Site.</td>
</tr>
</tbody>
</table>

The sanitary sewer and industrial process lines were identified and mapped in September 2007. The sanitary sewer lines include approximately 6,000 linear feet of pipe and 15 manholes. Each manhole will be flushed for ½ hour utilizing a Jet Pump and up to 500 ft of hose. Flushing activities will begin upstream and continue downstream toward the Imhoff Tank. All liquids and solids flushed from the manholes and sanitary sewer lines will be discharged to the Imhoff Tank. Upon completion of flushing activities, the top one foot of each manhole will be removed. Concrete will be pumped into each manhole pipe connection and the manhole will be filled with stone and compacted to grade. The pipe discharge at the Imhoff Tank will be capped with concrete.

The three industrial process lines that transport concentrated ammonium nitrate and urea process water between the north and south areas of the Site were identified and mapped in September 2007. The industrial sewer lines include the following approximate lengths:
- One 6-inch boiler feed water line totaling 2,500 ft in length (pipe volume of 3,670 gallons).
- One 6-inch stainless steel urea process line totaling 2,200 ft in length (pipe volume of 3,230 gallons).
- One 4-inch urea return line totaling 2,500 ft in length (pipe volume of 1,631 gallons).

Each of the above lines were located and excavated on each end. A receiving pit was excavated on the downstream end in order to capture the flushed liquids. A minimum of one pipe volume was flushed through each pipe and the fluids collected in the receiving pit. A vacuum truck was utilized to transfer the liquids from the receiving pit to either AST #5 or AST #6 for beneficial reuse. Upon completion, the excavated areas were backfilled with soil.

Documentation of the interim measures completed was provided to KDHE in a report dated December 31, 2008.

The actions for the lime sludge and water distribution lines are presented in Sections 6.7 and 6.18, respectively.

The sanitary sewer lines will be left in service until the East and West Effluent Ponds are desludged. At that time, the lines will be flushed and plugged. These activities will be funded from the Administrative Trust.

6.19.2 Costs

The scope of work associated with the above activities for the industrial process lines were completed in November 2008 for an approximate total cost of $9,150. These activities were funded from the Administrative Trust.

6.19.3 Additional Measures

At this time, no additional measures are anticipated to occur at the industrial sewer lines. The sanitary sewer lines will be addressed once the East and West Effluent Ponds are desludged.

6.20 AREA-WIDE-ASBESTOS REMOVAL

Asbestos containing materials (ACM) were used in the construction and operation of the Site because of its durability and heat insulating properties. ACM was used in all areas of the Site. It was used in Transite form on underground water pipes because of its durability and resistance to decomposition. It was used in the Transite form as building materials, specifically siding, roofing and interior walls. ACM were also used as an insulating material for piping and operational machinery where superior heat insulation was needed.

As installed, Transite is considered a non-friable form of ACM because it will not easily break up and form asbestos fibers small enough to be inhaled. Heat insulation usually is considered to be friable.

In approximately 1998, an asbestos survey was conducted on the Site which identified and marked the ACM on the Site. This survey did not identify and mark any underground Transite piping.
6.20.1 Interim Measures

During 2004 and 2005, before the dismantling of several of the plants, the ACM were removed and disposed in an acceptable landfill. Special Waste Authorizations were issued by the KDHE before the removal and disposal. Asbestos Removal and Maintenance, Inc. (ARMI) was contracted to do the removal and disposal.

Approximately 2200 cubic yards of ACM were removed from the Site and disposed in the Hamm’s landfill. The only areas of the facility that were not abated were the administration building, the laboratory and the underground piping.

6.20.2 Costs

The costs of the asbestos abatement project were $1,000,000, which was paid for with administrative funds and not with the FI Kansas Remediation Trust funds.

6.20.3 Additional Measures

ACM remains in place, specifically in the laboratory and underground piping. ACM may also be present in the administration building. At this time, the ACM is not friable and does not pose a risk. As a result, before the demolition of the laboratory and administration buildings, the presence of ACM in the buildings will need to be evaluated.

The location of the underground Transite piping has been determined to the best extent possible by review of the existing drawings from the Site. It should be understood that this identification of underground piping is neither exhaustive nor complete. There is in excess of 15,000 feet of ACM underground piping on site. The approximate locations of the known Transite lines are shown on Figure 6-3 and Figure 6-4. The removal, as necessary, of the Transite underground piping will occur as the Site is developed. Site-wide LURs will be required to notify potential purchasers of the presence of ACM on the Site in the form of buried Transite piping.

Further removal of any ACM left on the Site will not be undertaken by the Remediation Trust or the Administrative Trust. Any further ACM removal will be the responsibility of future purchasers of the Site.

6.21 LAND APPLICATION

While in operation, water that was impacted with nitrogen compounds was collected and recycled in the process. The water was collected in the Rundown Pond and Overflow Pond through a series of collection systems and smaller ponds. Impacted water came from two sources; impacted storm water and groundwater that were being removed as part of the groundwater corrective action. The water was used as cooling water in the ammonium nitrate/UAN (urea-ammonium nitrate solution) plant. Two waste heat evaporators, one at the Ammonia Plant and one at the Ammonium Nitrate Plant were used to evaporate the water and concentrate the nitrogen compounds. This concentrated water was then stored in the concentrate ponds on the Sandstone Hill or directly blended into the production of UAN.

Once plant production was shut down in 2001, the waste heat evaporators were no longer available to concentrate the water and UAN was no longer being produced where the
concentrated water could be used. A significant amount of water was stored in the Rundown and Overflow Ponds.

Because of the amount of water in the ponds and the continued collection of impacted water, concern for the structural integrity of the pond dikes increased. Therefore, options for the management of the impacted water were evaluated. One option evaluated was the land application of the water on farm ground for the beneficial use as nitrogen fertilizer. On September 6, 2002 a formal request to KDHE was made to initiate the public notice process necessary to amend the Corrective Action Decision to implement land application of the Rundown Pond water. The first phase of land application was on farm ground both south and north of the Kansas River between December 2002 and late March 2003 and again in the winter and spring of 2004. This first phase was accomplished using trucks and a floater applicator.

A second option approved by KDHE was blending the impacted water in the Rundown Pond/Overflow Pond with other storm water and discharging through the NPDES outfall. This option was only exercised briefly during late 2004.

6.21.1 Interim Measures

In 2004, it became apparent that land application using trucks and floater applicators was economically prohibitive and caused too much soil compaction on the farm ground. Several alternatives were evaluated and presented to KDHE in the Land Application Plan dated March 10, 2005. KDHE approved the Plan, as modified by letter, with final approval August 31, 2005. A copy of the Plan and modification letter is contained on the CD in Appendix C.

Before and concurrent with the development of the Land Application Plan, an agreement was reached with two farm owner/operators to land apply the nitrogen impacted water using their center pivot irrigation equipment. The two farm owner/operators were Pine Family Farms and Nunemaker-Ross Farms. Formal agreements were drawn up and signed by the owners and operators of each field.

In November 2007, several of the fields under agreement were sold by the owners. The new owner and operator has signed formal agreements keeping these fields in the land application program. The agreement states the conditions by which the farmers agree to accept the water and who has responsibility for equipment maintenance and severance conditions. The Plan attached in Appendix C includes an example copy of the agreement with land owners.

The Kansas Department of Agriculture Pesticide and Fertilizer Program (KDA) was contacted to determine the need for fertigation permits or registration of the water as a fertilizer product. In January 2005 KDA determined that, based on the proposed method of application, no fertigation permit would be needed to land apply the impacted water through center pivot irrigation systems. In a separate decision, the KDA adopted a policy dated August 9, 2005 that states that, in part, “fertilizer . . . contaminated waste materials produced in the process of implementing a KDHE approved remediation plan . . . may be distributed without registration, tonnage reports or payment of associated fees...”.

Diversion of groundwater and surface water for beneficial use requires the approval of KDA Division of Water Resources (DWR). Previous term permits to extract groundwater were in place covering the interceptor trenches. There were also water diversion permits in place that
allowed the Site to divert storm water for beneficial use while the Site was operational. However, a permit was not in place to allow the transfer of water to the fields north of the river. Therefore, a term permit application was submitted that allowed the collection of surface water runoff from the North Process Area and the Sandstone Hill area. This application also specified the disposition of the water on the fields through irrigation. This application was submitted in March 2005. At the same time, the earlier water diversion permits were dismissed in exchange for a term permit that allowed the collection of storm water from the same basic area. This permit was approved in April 2005.

Two AST’s were retained on Site for water management. Piping and pumping equipment that had been used to transfer UAN from the Site to a terminal located in North Lawrence (north of the Kansas River) were also retained. An extension of the pipeline to North Lawrence had previously been taken out of service. It was determined that modifications to this pipeline could be made so that water could be pumped to center pivot irrigation equipment for direct land application of the water. Several farm owned center pivot irrigation units were present in the fields that bordered the pipeline and could be used to apply the water directly to the fields.

The modifications to the pipeline consisted of re-opening the portion that had been removed from service and reconnecting it to the active pipeline. The pipeline was leak tested to insure the integrity of the line. Parts of the line were also inspected using a video camera. The complete pipeline location from the Site to the farm grounds north of the Kansas River is shown on Figure 6-5. At points along the pipeline in the center of each half section, a riser was installed on the pipeline. These risers make the water available to the center pivot irrigation units.

Transfer of the water from the pipeline to the center pivots, is accomplished using a booster pump and transfer hoses. The booster pump is a diesel driven pump with a pneumatically operated valve to shut off the water at the pump. As a safety feature to prevent the excessive water application in the event a center pivot stopped, a radio transmission/receiver unit was installed on the pump and the center pivot. If the center pivot looses power and stops, the radio equipment will signal the pneumatic valve to close and shut off the water flow to the center pivot. A hose reel and approximately 1600 feet of hose are used to connect the booster pump to the center pivots.

There were five fields along the pipeline that did not have farm owned center pivots already in place. To have adequate acreage to manage the impacted water, it was necessary to have these fields available for application. Two center pivot irrigation units were purchased for use in these fields. These units can be moved from field to field by the farm operators or by contract with irrigation equipment dealers.

At the Site, impacted water is collected in the Rundown Pond and Overflow Pond. This water must be transferred to the AST’s before it can be pumped to the center pivot irrigation systems. A diesel driven pump and associated piping is used to transfer the water from the ponds to the ASTs.

The first water land applied using the center pivot irrigation systems was in the fall of 2005. Water was applied in 2006 and again in 2007. The volume of water and pounds of nitrogen land applied is summarized in the table below.
## 6.21.2 Costs

During the period from August 1, 2005 through December 31, 2007 (approximately 2.5 years) a total of $187,217 was incurred in the performance of the scope of work associated with the land application program. A summary of these actual costs is provided in the following table.

<table>
<thead>
<tr>
<th>Period of Performance</th>
<th>Cost Category</th>
<th>Land Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/01/05 through 08/30/06</td>
<td>Labor</td>
<td>$19,277</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$31,381</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$50,658</td>
</tr>
<tr>
<td>09/01/06 through 12/31/07</td>
<td>Labor</td>
<td>$41,430</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$95,129</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$136,559</td>
</tr>
<tr>
<td>TOTALS</td>
<td>Labor</td>
<td>$60,707</td>
</tr>
<tr>
<td></td>
<td>Expenses</td>
<td>$126,510</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td>$187,217</td>
</tr>
</tbody>
</table>

Major expenses incurred in association with the land application program during the period from September 1, 2006, through December 31, 2007, include the following items:

- $13,348 in electrical usage has been estimated for operation of the pumps associated with the land application program. Electrical usage for these pumps is not metered separately, and appears on the electrical bill for the entire site. Electrical usage over this period was estimated based on pump size and estimated hours of operation using the current electrical fee of $0.071/kilowatt-hour.
- $25,432 was incurred for repairs to a center pivot system as a result of storm damage.
- $3,709 was incurred for general maintenance and moving of the center pivot irrigation systems.
- $39,903 was incurred for the purchase in January 2007 of a trailer-mounted diesel-powered dewatering pump to facilitate moving water from the ponds to the above ground storage tanks. $9,965 in diesel fuel expenses has been incurred to operate the pump during calendar year 2007.
$2,772 was incurred for insurance on the center pivot irrigation system.

The costs associated with the land application of water in 2002 through 2004 using the floater equipment was paid for with administrative funds and not with the FI Kansas Remediation Trust funds and are not reflected in the costs above.

The land application program is assumed to be required for a minimum 30-year period. The annual operation and maintenance costs over this 30-year period are estimated at $50,100. Further details on the future costs for the land application program are provided in Section 7.1.2.

6.21.3 Additional Measures

The land application of impacted water will continue for a minimum of 30 years resulting from the continued collection of groundwater and storm water impacted with nitrogen. At a minimum, there will continue to be groundwater collected from the existing interceptor trenches and depending on the final decision concerning the discharge of water from the Site to the Kansas River, there may also be continued collection of impacted storm water.

Continued land application will require ongoing operations and maintenance cost associated with the equipment, management of the distribution of the water, and reporting to the KDHE and KDA as required by permits.

Projected major costs would include the possible rebuilding of the two diesel pumps and engines, the two Trust owned center pivot irrigation units, the electric motors and pumps used to pump the water into the pipeline and repairs to the internal Site piping and pipeline. Other costs include the purchase of diesel fuel and electricity to run the pumps. A more detailed evaluation of the additional remedial actions as well as a more detailed cost estimate is provided in Section 7.1.2.
7.0 Remedial Action Plan – Areas Proposed for Active Remediation

The remedial actions presented in this section were developed and evaluated based on the results of site characterizations, development of remedial action goals, and evaluation of various remedial alternatives. After consultation with both KDHE and EPA, the remedial actions were further prioritized based on several issues: 1) the responsible party (Farmland Industries) is in bankruptcy; 2) there is a limited amount of funding available in the Trust to remediate all environmental contamination issues at the property; 3) land use of the property will remain as non-residential; and 4) the Trust is interested in selling the property for future redevelopment.

The scope and order of priorities were finalized following submittal of a draft RAP in December 2007, and incorporating KDHE and USEPA comments as outlined in correspondences dated August 26, October 15, and October 21, 2008 and scoping meetings on September 23, October 8, and October 22, 2008.

The remedial actions identified for the Site fall into the following three categories:

1. Primary Remedial Priorities – remedies to be either continued and/or implemented immediately using funding from the Remediation Trust:
   a. Continue operation and enhancement of the groundwater monitoring network;  
   b. Continue operation and enhancement of the groundwater containment system at the Site including land application of impacted water, to the extent feasible, for a minimum period of 30 years;  
   c. Record and file with the County Register of Deeds Office LURs to control future uses and activities at the Site; and  
   a. Continue Post-Closure Care monitoring of the CRS Unit in accordance with the requirements of the KDHE Bureau of Waste Management.

2. Development Priorities - to be implemented in coordination with future Site development plans or, if the property is not sold within five years, by funding from the Administrative Trust:
   a. Modify infrastructures, operations, and maintenance of storm water management systems to meet the needs of future development plans and maintain current NPDES requirements. This includes removal of sludge from the East and West Effluent Ponds so they can be utilized for future non-contact storm water detention.

3. Secondary Remedial Priorities – to be implemented based on available funding in the Remediation and Administrative Trusts or by a prospective purchaser through financial assurance:
   a. Excavation and management of impacted soils in select areas of the Site to improve storm water runoff quality;
b. Excavation and management of impacted soils to accommodate future development or construction;
c. Final closure of the northern ponds, including the Overflow Pond.

7.1 PRIMARY REMEDIAL PRIORITIES

7.1.1 Groundwater Containment System

The first priority is maintaining hydraulic control of groundwater impacted by nitrogen compounds utilizing the existing groundwater containment system, with enhancements, disposal of the impacted water (included impacted storm water runoff) through the existing land application system, and continued monitoring using the existing groundwater monitoring network, with several additional monitoring locations. Proposed enhancements to the existing groundwater containment system include the installation of an interceptor trench in the Central Ponds area to capture groundwater seepage that impacts surface water quality, the installation of a sump/pump system associated with the Dam Pond, and the installation of an alluvial aquifer pumping well north or northwest of the Bag Warehouse.

As a result of the limitations of the Trust, moderate to high levels of nitrogen compounds (nitrate, nitrite and ammonia) will remain in the subsurface at the Site for an extended period of time. Therefore, continued operation of the enhanced groundwater containment system for a minimum period of 30 years is required to ensure groundwater impacted by nitrogen compounds does not migrate off-site and impact downgradient water resources. An existing ground water monitoring network has been established and will be monitored on a quarterly basis or as otherwise approved by KDHE to ensure that on-site contamination is being hydraulically contained.

7.1.1.1 Existing Ground Water Monitoring Network

As previously described in Section 6.16, the existing groundwater monitoring network was modified during interim actions at the Site in 2007. The proposed future monitoring network is shown on Figure 7-1 and includes the addition of five wells.

Groundwater across the Site consists of several different units, four of which have been identified as being impacted or having the potential to be impacted. Three of the units do not have sufficient permeability and/or saturated storage to make them useable sources of water. The three units with insignificant potential for water production are the overburden unit (most notably in the vicinity of the CRS unit and also discontinuously across the Site), the bedrock unit (most notably in the Sandstone Hill), and the silty clay unit underlying the ponds in the northeast portion of the Site. The silty clay and overburden units are essentially the same unit, being distinguished only by their location. The only aquifer with the potential for sustainable yield is the Kansas River alluvial aquifer that borders on the north edge of the Site. The extent of the various groundwater units based on previous investigations is displayed on Figure 7-2. Monitoring wells are installed in each of these groundwater units. This section provides an evaluation of the groundwater monitoring network that exists in the three water-bearing units located at the Site: the bedrock unit, the silty clay overburden unit, and the Kansas River alluvial aquifer.

Bedrock unit
Based on well logs, there are two wells screened completely in the bedrock unit. These are PW-01 and PSW-13B. Wells N-1 and N-2 are screened across the silty clay unit and the bedrock unit. Wells screened across the Kansas River alluvial aquifer and the bedrock units are PW-04A and PW-05.

During the site characterization activities, nitrate-nitrogen concentrations ranged from less than 0.06 to 1,780 mg/L in the bedrock unit. The highest concentrations were in PW-01 (1,780 mg/L) east of the process area and in N-2 (1,620 mg/L) on top of the Sandstone Hill. Ammonia-nitrogen concentrations greater than 10 mg/L were only found in wells PW-01 (900 mg/L) and N-2 (1,140 mg/L).

The bedrock unit does not have the capability to yield groundwater in sustainable quantities on the Site because of the presence of significant mudstone and shale strata within sandstone unit. Geophysical data collected during the 2007 Sandstone Hill investigation also revealed discontinuous permeable zones and thin intervals exhibiting visible water moisture. The existing groundwater containment system which consists of a series of interceptor trenches and pumping wells is effective at indirectly recovering groundwater from this unit and prevent it from impacting the alluvial aquifer. Based on these facts, it is recommended that no continued or additional monitoring be proposed for the bedrock unit.

Silty Clay Unit

Wells interpreted to be screened entirely in the silty clay unit include PSW-1A, PSW-2A, PSW-3A, PSW-5A, PSW-6A, PSW-7A, PSW-9A, PSW-13A, PSW-17, and PSW-18. These wells are primarily located in the area of the northern ponds, both up gradient and down gradient. With the exception of PSW-13A, these wells are monitored quarterly to evaluate the quality of the groundwater existing in the silty clay and to evaluate the effectiveness of the groundwater management and containment system.

During Site characterization activities, several groundwater samples collected by direct-push methods were interpreted to be in the silty clay unit. These were collected in the northeast portion of the Site around the Krehbiel, West and West Extension Ponds, and the North Process Area (the area to the west and south of the Big Bag Warehouse). Samples were also collected in the area to the south of the No. 2 Urea Bulk Warehouse and in the Nitric Acid Process Area, both of which are located in the South Process Area of the Site.

Sample results from the monitoring wells and the direct-push samples indicate that the silty clay unit is impacted by nitrogen compounds primarily in the northern portions of the Site. Concentrations of nitrate-nitrogen in the silty clay unit range from 0.15 mg/L to 33,310 mg/L. Nitrate-nitrogen concentrations were highest near the Krehbiel, West and West Extension Ponds. Ammonia-nitrogen concentrations ranged from less than 0.06 mg/L to 51,640 mg/L in the area of the Krehbiel, West and West Extension Ponds.

The nine wells listed above are monitored quarterly to evaluate the groundwater found in the silty clay unit. The system in place is considered to be adequate to monitor the quality of the silty clay unit in the areas of the northern ponds (Area B) on the Site. There are no routinely monitored wells installed in the silty clay unit west of PSW-18. One groundwater sample collected during the Site characterization activities in this area (A01W-GW-03) had ammonia-nitrogen concentrations of 265 mg/L and nitrate-nitrogen concentrations of 478 mg/L concentrations.
Therefore, it is recommended that a well be installed west of sampling point A01W-GW-03 to monitor groundwater quality in this area. The existing nine wells and the new well will be monitored on a quarterly basis.

**Kansas River Alluvial Aquifer**

Wells PSW-01B, PSW-02B, PW-03B, PSW-04, PSW-06B, PSW-09B and PSW-15 are installed in the Kansas River alluvial aquifer. PSW-05B and PSW-07B have been considered to be installed only in the deep alluvial aquifer for the purposes of monitoring and evaluating the alluvial aquifer in past monitoring activities. These wells are primarily located in the area of the northern ponds, both up gradient and down gradient from the ponds. These wells are monitored quarterly to evaluate the quality of the groundwater existing in the alluvial aquifer. This monitoring also allows the evaluation of the groundwater management and containment system.

There are a few other wells located to the west of the existing monitoring network that are installed in either the alluvial aquifer, the alluvial aquifer/silty clay units or the alluvial aquifer/bedrock unit.

Nitrogen impacts to the alluvial aquifer are minimal with the highest nitrate-nitrogen concentrations found in PW-09 at 24.2 mg/L. Ammonia-nitrogen concentrations are similar with the highest concentrations found in PW-09 at 31.9 mg/L. PW-09 is located in the northwest corner of the Site. During the Site characterization activities in 2005 well PW-04A contained nitrate-nitrogen concentrations of 647 mg/L. This well is screened across the alluvial aquifer and the bedrock unit.

Results of the direct push (Geoprobe™) samples collected by KDHE in late September and early October 2008 in the vicinity of Krehbiel Pond indicate the existing monitoring network should be supplemented in the north-central portion of the Site. One new monitoring well screened in the alluvial aquifer and one new well screened in the silty clay unit are recommended between PSW-04A and PW-05 to provide adequate coverage in this area.

In addition, KDHE sample results indicated the potential for off-site migration of groundwater impacted by nitrogen compounds in the northwest portion of the Site (near the Bag Warehouse). The existing monitoring network is not sufficient for monitoring the water quality in the Kansas River alluvial aquifer in that area of the Site. An additional set of monitoring wells should be installed north of the Bag Warehouse to better monitor the water quality in the Kansas River alluvial aquifer in the northwest portion of the Site.

To increase the adequacy of the monitoring network for the Kansas River alluvial aquifer, the following actions are proposed:

- Installation of two new monitoring wells located between PWS-04A and PW-05.
- Inclusion of existing well SW-10A in the quarterly monitoring program.
- Installation of two new monitoring wells to the north of the Bag Warehouse near KDHE sample location WE-1.
- Installation of a new alluvial aquifer monitoring well north of 15th Street.
The inclusion of these wells into the quarterly monitoring program should provide adequate monitoring of the alluvial aquifer in the northwest portion of the Site. The locations of these wells are illustrated on Figure 7-1.

7.1.1.2 Existing Groundwater Containment Systems

The groundwater containment system consists of various systems installed and operated during the last 30 years. The origins and purposes of each of these systems were previously discussed in greater detail in Section 3. The installation and operation of the various interceptor trenches and recovery wells over time has been determined to be effective in preventing the migration of nitrate and ammonia contaminated groundwater through hydraulic containment. An evaluation of the existing groundwater containment system is provided in the following sections. The locations of various interceptor trenches and recovery wells which make up the groundwater containment system are detailed in Figure 7-3.

7.1.1.2.1 North and South Interceptor Trenches

Two interceptor trenches were installed in a groundwater unit at the bottom of the Sandstone Hill in 1975. One trench is located just south of the Krehbiel Pond and the other is north of the present West and West Extension Ponds along the north side of the in-plant railroad tracks. The groundwater originating in the bedrock unit on the Sandstone Hill and in the overlying overburden unit is the source of the water removed by these interceptor trenches. These trenches are commonly known as the North and South Interceptor Trenches. The locations of these trenches are shown on Figure 7-3 and are both are approximately 500 feet long.

These interceptor trenches are installed from 12 to 15 feet deep, intercepting water at those depths. A summary of data collected over the last eight years is shown in the table below. This data includes the average gallons recovered per quarter from each trench, the average nitrate-nitrogen concentration and the concentration range for all the samples collected from these trenches over the last eight years. There has been a gradual decline in the concentrations noted especially in the North Interceptor Trench.

<table>
<thead>
<tr>
<th>Trench</th>
<th>Average Gallons of water/quarter recovered</th>
<th>Average Nitrate-nitrogen Concentration (mg/L)</th>
<th>Nitrate-nitrogen Concentration Range (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>218,000</td>
<td>1400</td>
<td>110-3050</td>
</tr>
<tr>
<td>South</td>
<td>150,000</td>
<td>1300</td>
<td>560-2450</td>
</tr>
</tbody>
</table>

Two monitoring wells, PSW-18 and PSW-5A (silty-clay unit), located to the north of the North Interceptor Trench are monitored quarterly for nitrate-nitrogen. The nitrate-nitrogen concentration in PSW-18 has declined over the last eight years, with an average concentration of 39 mg/L. The maximum reported concentration in this well was 152 mg/L in February 2000. Monitoring
well PSW-5A has averaged 8.2 mg/L nitrate-nitrogen with a range of 3.1 mg/L to 12.6 mg/L over the last eight years.

The monitoring data from these wells, although they are installed slightly deeper than the interceptor trenches, indicate that the North and South Interceptor Trenches are effectively recovering and removing nitrate impacted groundwater from the overburden near the Sandstone Hill. The North and South Interceptor Trenches are considered adequate for the control and containment of impacted groundwater from the overburden unit and possibly indirectly from the bedrock unit.

The trenches and monitoring wells are sampled and evaluated quarterly. Quarterly performance evaluation reports have been provided to the KDHE since March 1998.

### 7.1.1.2.2 Northwest, Northeast and Southeast Interceptor Trenches

Three interceptor trenches are installed in the silty clay unit in the northeast area of the Site. These trenches were installed based on a 1995 investigation that consisted of mathematical modeling of both the silty clay zone and the alluvial aquifer. The trenches were placed into operation in 1998. Two are located along the north side of the northern ponds in Area B. These two trenches are approximately 2,750 feet long combined. The third is installed along the east and south sides of the Rundown Pond and Overflow Pond. This trench is approximately 1,450 feet long. The groundwater originating in the silty clay unit is the source of the water removed by these trenches. These trenches are commonly known as the Northwest (NW), Northeast (NE) and the Southeast (SE) Trenches. The location of these trenches is shown on Figure 7-3.

These interceptor trenches are installed from 8 to 12 feet deep and intercept water at those depths. A summary of data collected over the last eight years is shown in the table below. This data includes the average gallons recovered per quarter from each trench, the average nitrate-nitrogen concentration and the concentration range for all the samples collected from these trenches over the last eight years.

<table>
<thead>
<tr>
<th>Trench</th>
<th>Average Gallons of water/quarter recovered</th>
<th>Average Nitrate-nitrogen Concentration (mg/L)</th>
<th>Nitrate-nitrogen concentration range (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NW</td>
<td>760,000</td>
<td>3200</td>
<td>966-5620</td>
</tr>
<tr>
<td>NE</td>
<td>114,000</td>
<td>1350</td>
<td>295-4026</td>
</tr>
<tr>
<td>SE</td>
<td>296,000</td>
<td>810</td>
<td>88-2031</td>
</tr>
</tbody>
</table>

The NW Trench has had a significant decline in the nitrate-nitrogen concentration over the last three to four years. The nitrate-nitrogen concentration during the four quarters of 2007 has averaged 1020 mg/L. This decline in concentration is an indicator that water quality in this portion of the silty clay unit is continuing to improve. This improvement in water quality is likely a result of the removal of the more highly impacted water in the Rundown Pond and Overflow Pond.
The average concentration reported from the NE Trench is 740 mg/L nitrate-nitrogen over the four quarters of 2007, a significantly lower average than the eight year average of 1350 mg/L shown above. The decline in concentration in the NE Trench has not been as dramatic as that of the NW Trench but there is still a noticeable declining trend.

The average concentration in the SE Trench over the four quarters of 2007 is 770 mg/L nitrate-nitrogen. This compares with the eight year average of 810 mg/L. This trench is situated on the south and east sides of the Rundown and Overflow Ponds on the up gradient side of the ponds.

There are 9 wells constructed in the silty clay unit. Five of these wells are located directly down gradient from the interceptor trenches. The five wells are PSW-2A, PSW-3A, PSW-5A, PSW-6A and PSW-7A. Wells PSW-3A, 6A, and 7A are the closest to the source of the nitrate-nitrogen. The average, maximum, and minimum nitrate-nitrogen concentration reported in these wells during the monitoring program started in 1997 are shown in the following table:

<table>
<thead>
<tr>
<th>Monitoring Well</th>
<th>Average Nitrate-nitrogen concentration (mg/L)</th>
<th>Maximum Nitrate-nitrogen concentration (mg/L)</th>
<th>Minimum Nitrate-nitrogen concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSW-3A</td>
<td>2240</td>
<td>4275</td>
<td>276</td>
</tr>
<tr>
<td>PSW-6A</td>
<td>3330</td>
<td>7740</td>
<td>107</td>
</tr>
<tr>
<td>PSW-7A</td>
<td>790</td>
<td>1960</td>
<td>166</td>
</tr>
</tbody>
</table>

The nitrate-nitrogen concentrations in all three wells have declined during the course of the groundwater recovery. Reported concentrations in PSW-3A, PSW-6A, and PSW-7A during the four quarters of 2007 were 388 mg/L, 680 mg/L, and 201 mg/L respectively. These averages are significantly less than the long term averages shown above.

The wells (PSW-2A and PSW-5A) which are located towards the ends of the long northern interceptor trench exhibit nitrate-nitrogen concentrations of 9.2 mg/L and 11 mg/L respectively.

The declining nitrate-nitrogen concentrations in the water recovered by the interceptor trenches as well as in the shallow monitoring wells immediately down gradient of the interceptor trenches are indicators that the interceptor trenches are effectively controlling the impacted groundwater in the silty clay unit beneath the ponds. These trenches are considered adequate for control and containment of the impacted groundwater from the silty clay unit.

The trenches and monitoring wells are sampled and evaluated quarterly. Quarterly performance evaluation reports have been provided to the KDHE since March 1998.
7.1.1.2.3 Recovery Wells

The Kansas River Alluvial aquifer located north of the Site, with its southern edge contacting the northern edge of the Site is considered capable of sustainable yields of water. This aquifer is used for both public and private water supplies.

There are 14 wells on Site that are installed either totally or partially in this alluvial aquifer. Nine of these wells are monitored on a routine basis to determine the water quality with respect to nitrogen compounds. Five of these wells are located along the northern edge of the Site. These wells are PSW-2B, PSW-3B, PSW-5B, PSW-6B, and PSW-7B. All these wells are constructed with the screens installed in the alluvial sands at approximately 50-60 feet deep.

Three of these wells, PSW-3B, PSW-6B and PSW-7B, are constructed as recovery wells pumping water from the aquifer to control and contain nitrogen compounds which may reach the alluvial aquifer. This water is directed to a NPDES-permitted outfall which flows to the Kansas River.

PSW-6B was originally installed as the recovery well in the area of highest concentration of nitrate-nitrogen. After installation, the initial nitrate-nitrogen concentration was reported as greater than 1000 mg/L. Following nine months of operation, the concentration dropped to less than 100 mg/L. During the next 24 months of operation the concentration declined further to less than 10 mg/L where it has remained since May of 2001 with the exception of two monitoring events (25 mg/L and 10.4 mg/L).

Two recovery wells were installed as PSW-3B in 2001 and PSW-7B in 2002 because of increasing nitrate-nitrogen concentrations in the alluvial aquifer in those locations. In both of these cases the nitrate-nitrogen concentrations spiked rather quickly to concentrations in the 80-160 mg/L range. Once the pumps were installed and operational, the nitrate-nitrogen concentrations in these wells quickly declined to less than 10 mg/L.

Monitoring wells located down gradient from the ponds routinely have reported nitrate-nitrogen concentrations below 10 mg/L indicating that the impacted water is not migrating off-site.

The rapid reduction in nitrate-nitrogen concentrations in these wells is evidence that the pumping of the aquifer is controlling the migration of groundwater that may have been impacted. The pumping of these wells is considered adequate for control and containment of nitrogen compounds that may impact the Kansas River alluvial aquifer in the area north of the northern ponds.

The recovery and monitoring wells are sampled and evaluated quarterly. Quarterly performance evaluation reports have been provided to the KDHE since March 1998.

7.1.1.2.4 Existing Land Application System

The management of water, both groundwater and storm water, is considered to be a long-term environmental issue relating to the Site. Storm water is managed by either allowing it to flow unimpeded to the Kansas River or by collection for other management options. Groundwater is managed by removal as necessary to protect the Kansas River Alluvial Aquifer. Once the water is removed, water is either discharged to the Kansas River or collected for other management options. The determination as to whether the water, either storm or groundwater, can be discharged to the Kansas River is based upon the NPDES permit issued by the KDHE.
Currently, water that exceeds the NPDES permit limitations is captured and stored for disposal through land application. Water that is being collected for land application comes from two sources: groundwater and storm water runoff. Historically, groundwater impacted with nitrogen compounds has been collected in the series of interceptor trenches and extraction wells along the northern portion of the Site. The storm water runoff comes from the northern portions of the Site where storm water is impacted by surface soil and groundwater seeps that daylight as surface water. In most areas, this water is much less concentrated than the groundwater collected in the trenches. In isolated areas, the storm water has been impacted to a greater degree by nitrogen compounds, but the volume of storm water runoff from these areas is small.

Before the shutdown of the Farmland plant, nitrogen-impacted water was captured and recycled for use in the plant for production processes. Beginning in 2002, following shutdown of the plant, storm water and recovered groundwater that contained concentrations of nitrogen compounds above the NPDES discharge permit levels were contained on-site in two existing ASTs as well as the Rundown and Overflow Ponds. Initially, this water was transported to agricultural fields located north of the Site and land applied on crops for the beneficial use of the nitrogen compounds in the water as fertilizer. This process for land application was discontinued in 2004. Beginning in 2005, the water was pumped from the Site through existing piping to agricultural fields north of the Kansas River. To date, approximately 71.3 million gallons of impacted water have been land applied, removing an estimated 2,224,200 pounds of nitrogen from the Site for beneficial use. Land application of nitrogen-impacted water is practical and feasible when concentrations are sufficient to allow application of agronomic quantities of nitrogen without applying excessive quantities of water. The amount of water that a field can receive is dependent on the several factors, including the concentration of nitrate in the water, prevailing moisture condition in the field, and time in the growing season.

7.1.1.3 Groundwater Containment System Enhancements

Four distinct groundwater units have been identified and investigated at the Site. Groundwater in the bedrock unit, overburden unit, and silty clay unit ultimately flows down gradient to the alluvial aquifer beneath the Kansas River floodplain. As previously discussed, water quantity in the overburden, silty clay, and bedrock units are limited. The remedial action goal of the groundwater containment system is to protect the quality of water in the alluvial aquifer.

The conceptual groundwater migration model for the Site includes groundwater in the bedrock unit in the Sandstone Hill discharging to overburden sediments and migrating toward the north. Groundwater in the overburden unit discharges to the silty clay unit and possibly also directly to the alluvial aquifer beneath the silty clay unit. Very shallow groundwater in the overburden unit is intercepted by the North and South Interceptor Trenches. Some groundwater from the Sandstone Hill also exits the hill through seeps and becomes surface water. Surface water from the hill is discussed further in Section 7.1.1.3.2 and 7.1.1.3.3.

Groundwater originating in the overburden unit migrates on a site-wide scale toward the north, following topographic contours down slope. Some downward migration into the underlying bedrock unit is possible. The overburden unit transitions into the silty clay unit beneath the Area B ponds, and the silty clay unit terminates in the floodplain north of the Site. The approximate aerial extent of the various groundwater units is shown in Figure 7-2.
Although the existing operating groundwater containment systems are effectively capturing shallow groundwater and inhibiting migration into the deeper alluvial aquifer in the north and northeast portions of the Site, two potential inadequacies were identified in the existing system as presently configured. First, migration of elevated nitrate concentrations from the Sandstone Hill into the alluvial aquifer appears to be taking place to the west of the existing North and South Interceptor Trenches and near the west end of the Bag Warehouse building. Evidence of this is seen in samples collected from well PSW-04A northwest of the Krehbiel Pond (Site Characterization Report, 2006), in sample data from quarterly monitoring (Performance Evaluation Report, Sept. 2008), and in data collected during KDHE supplemental investigation conducted in September-October 2008; Appendix C).

Secondly, the North and South Interceptor Trenches may not be constructed deep enough to intercept all groundwater migrating from the Sandstone Hill to the silty clay unit and alluvial aquifer. Presently, water exiting the Sandstone Hill can migrate through sandy overburden sediments (which are present between clayey overburden and the sandstone unit) directly into the alluvial aquifer. Based on drilling logs from this area, the sandy overburden and alluvial aquifers are connected laterally (see Figures 2-3A and 2-3B).

The following section provides a discussion of alternative methods to address identified inadequacies in the existing groundwater containment system.

### 7.1.1.3.1 New Recovery Well

#### Evaluation of Alternatives

Three potential methods have been identified for addressing the potential migration of nitrate-contaminated groundwater off-site in the vicinity of the Bag Warehouse and reaching the alluvial aquifer. The identified alternatives are:

- **No action.** Continue recovering water from existing trenches and pumping wells. No change to discharge logistics.
- **Install submersible pump and recover water from existing well PW-04A (northwest of Krehbiel Pond).** Discharge water to existing above-ground storage tank for future land application.
- **Install three additional monitoring wells downgradient from existing well SW-10A, monitor existing and newly installed wells on a quarterly basis to determine the need and location of a new pumping well located near existing well SW-10A.** Pump water to NPDES discharge point, if nitrogen concentrations meet NPDES permit limit (volume of water is expected to be too great for use in land application).
The following table provides an evaluation of the identified alternatives for improvements to the groundwater containment system.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>No action. Continue recovering water from existing trenches and pumping wells. No change to discharge logistics.</td>
<td>No additional cost.</td>
<td>○ Provides limited capture of impacted groundwater entering the alluvial aquifer beneath the interceptor trenches.</td>
<td>○ Current groundwater containment system may be providing adequate protection to alluvial aquifer, based on limited available monitoring data. ○ No additional cost.</td>
</tr>
<tr>
<td>Install submersible pump and recover water from existing well PW-04A. Discharge water to NPDES discharge point.</td>
<td>$60,000 Based on ability to rehabilitate PW-04A.</td>
<td>○ Long-term well maintenance required. ○ Does not address impacted groundwater at west end of Bag Warehouse. ○ Quality of water during sustained pumping is unknown and will require a pumping test to determine. ○ Quantity of water disallows use in land application discharge.</td>
<td>○ Efficient use of existing well. ○ Inhibits further migration of elevated nitrate levels into alluvial aquifer from northwest corner of Sandstone Hill.</td>
</tr>
<tr>
<td>Install new pumping well near existing well SW-10A and install three monitoring wells down gradient and two wells SE of Bag Warehouse. Pump water to NPDES discharge point.</td>
<td>$67,675 Based on assumption that sufficient clean water is also captured to provide water quality adequate for NPDES discharge. O&amp;M costs are included in the O&amp;M task.</td>
<td>○ Long-term well maintenance required. ○ Quantity of water disallows use in land application discharge option. ○ Water handling problem if concentrations too high for NPDES discharge. May require higher than necessary pumping rate.</td>
<td>○ Inhibits further migration of elevated nitrate levels into alluvial aquifer from northwest corner of Sandstone Hill.</td>
</tr>
</tbody>
</table>

The remedial alternatives identified above were developed based on the conclusion that elevated nitrate concentrations are entering the alluvial aquifer from the Sandstone Hill and that containment of this impacted groundwater is necessary to protect the alluvial aquifer system. The existing alluvial pumping wells may be capable of capturing this impacted water. Recent KDHE investigation data (2008) indicates the existing system is adequately controlling migration to the north of Krehbiel Pond, but that off-site migration may be occurring in the northwest corner of the Site.
Preferred Remedial Alternative

The preferred remedial option is the installation of three additional monitoring wells near KDHE sample location WE-1 located to the north of the Bag Warehouse and SW-10A located just west of the Bag Warehouse. The existing and newly installed monitoring wells will be monitored quarterly and the data evaluated to determine if a pumping well is needed, and if so, the location of the well. If a new pumping well is determined to be necessary, a new pumping well will be constructed and placed into operation. The locations of the three proposed monitoring wells are shown on Figure 7-1. Funding will be set aside to design, install and operate a pumping well for 30 years.

Based on the estimated costs, the likely volume of water involved, and previous history from the other alluvial aquifer pumping wells, it is recommended that discharge to the NPDES outfall be utilized.

Expansion of the shallow groundwater monitoring network in the area of the Bag Warehouse will provide additional information needed to confirm effective capture of overburden groundwater.

7.1.1.3.2 Interceptor Trench – Central Ponds Area

A portion of Area A known as the Central Ponds was identified in the Site Characterization Report (Shaw, 2006) as an area of concern based on unusually high concentrations of nitrate and ammonia in shallow soil samples. The Central Ponds are located south of the Sandstone Hill area in the western half of Area A (see Figure 2-7 and Figure 3-1) and encompass an area of approximately 0.6 acres. The function of the ponds during Site operations was the collection of surface water drainage off the south flank of the Sandstone Hill. The ponds were also designed to buffer storm water runoff during heavy rain events. The surface water flow in this area of the Site is presently controlled by engineered ditches leading to the six primary ponds located along the northern boundary of the Site. As a result of these findings, the Central Ponds underwent an interim removal action in May and June, 2006, which included filling and grading to prevent ponding of water. Additional details on the interim action are provided in Section 6.1.

Subsequent to the completion of the interim action, storm water and shallow groundwater seepage from the Sandstone Hill area has continued to intermittently flow into the area of the former Central Ponds. To prevent future impact to surface soils and surface water down slope, remedial action was evaluated in the area.

This section discusses remedial actions in the former Central Pond area directed at shallow groundwater seepage and its effect on surface soils and storm water runoff.

Surface soils have not been sampled since the time of the Site Characterization work in 2005. However, groundwater seeps have been observed flowing in the Central Ponds area. Crystallized residue from evaporated seep water has also been observed on the ground surface near the former ponds. Sampling of seeping groundwater indicated ammonia at 2,400 mg/L and nitrate at 4,500 mg/L. Analysis of samples of the crystallized residue suggests that it is comprised of ammonium nitrate.

Following the interim remedial measure carried out on the Central Ponds, shallow soil concentrations were determined to be below the remedial action target levels for nitrate and
ammonia. Results of this sampling are contained in the Interim Remedial Measures report submitted to KDHE on September 1, 2006. However, as a result of the observed groundwater seepage in the area of the Central Ponds, it appears surface soils have been impacted by nitrogen compounds. The impacts to the surface soils in this area are evidenced by crystallized residue from evaporated seep water on the ground surface. Remedial action is recommended to prevent future accumulation of nitrate or ammonia in surface soils caused by seeping shallow groundwater.

Potential remediation options to prevent future impacts include:

- No action; rely on proposed remedy for Sandstone Hill/Concentrate Ponds area.
- Extraction well network – Installation of a network of shallow extraction wells in the Sandstone Hill area and/or Central Ponds area to de-water the saturated sandstone and overburden and prevent down gradient migration. Extracted water would be pumped to land application storage tank.
- Interception trench – Installation of an interception trench immediately upgradient of known seeps (located adjacent to the Central Ponds) and south of the Hill Crest and former Concentrate Ponds area. Interception trench bottom would be notched into sandstone bedrock surface. Captured water would be directed by piped gravity flow to existing ponds in Area B for eventual discharge by land application. Soil generated during trench installation would be placed in Area B ponds for disposal.

Evaluation of Alternatives

Groundwater seepage in the area of the Central Ponds is interpreted to be from overburden material only. Impacted groundwater within the sandstone bedrock has been identified at the base of the sandstone unit at an elevation below the observed impacts. Therefore, the bedrock unit groundwater is not likely to exit the Sandstone Hill through a surface seep except at a point of bedrock exposure east of the Central Ponds. Therefore, the evaluation of alternatives is based on the assumption that impacted groundwater originates from within approximately the upper six feet of the subsurface.

The following shallow groundwater remediation options were identified and evaluated for this area.
**Preferred Remedial Alternative**

The preferred remedial option for impacted groundwater seepage in the former Central Ponds area is an interception trench with gravity discharge of water to existing ponds. The trench will prevent further seepage of nitrogen compounds from the hillside to the surface, and it will thus eliminate a source of surface soil, surface water, and storm water soil impacts. Spot removal of impacted soils will be undertaken in the area of and along the service road north of the former pond.

*Figure 7-4* illustrates the estimated location for the interceptor trench and effluent piping.

### 7.1.1.3.3 Dam Pond Sump

Impacted surface water was identified in the drainage rill at the northwest corner of Area A in a 1982 study of surface water and soil impacts (Currens, 1982). The study included the collection of storm water runoff during rain events and soil samples from various plant areas and drainage ditches on the northern parts of the Site. This surface water runoff is assumed to have created soil impacts in the Dam Pond sediments. Current data indicates that storm water runoff in the drainage rill typically contains 100 to 700 mg/L nitrate. Water is currently diverted into an HDPE pipe, which leads to the Krehbiel Pond in Area B. From there, water is pumped to the West
Pond, West Extension Pond, and eventually to the Rundown Pond. As the Rundown Pond will be filled with impacted sediments and soils from other areas of the Site, modifications will be made to capture the water diverted by the Dam Pond for land application.

It is anticipated that the capture of surface water in this drainage rill will continue until soil remediation is completed in the Sandstone Hill/Condensate Pond area.

**Land-Use Restrictions**

Storm water runoff to the Dam Pond will be influenced by the LUR put in place for the remediation of surface soils in the Sandstone Hill/Condensate Pond area as well as the LUR put in place to maintain the Dam Pond.

**Preferred Remedial Alternative**

No new remedial action is recommended for surface water in the Dam Pond area. However, modifications will be made to capture the water from the Dam Pond for land application rather than diversion to the Area B ponds.

The modifications will include installing a sump where the HDPE pipe from the Dam Pond enters Krehbiel Pond. The sump will be equipped with a pump and connected to piping that extends to the ASTs. As water enters the sump from the Dam Pond, it will be pumped to the ASTs for future land application. The costs for installing the sump, pump, piping, and providing electrical service for the pump are estimated to be $51,550.

Storm water runoff to the Dam Pond will be improved by the remedial action carried out in the Sandstone Hill/Condensate Pond area. However, impacted shallow groundwater may still create high nitrate levels in the drainage rill surface water. For this reason, the Dam Pond should be left in place and maintained in functioning condition. **Figure 7-5** illustrates the Dam Pond and existing water diversion pipe.

### 7.1.1.4 Summary of Annual Costs of Operation of Groundwater Containment System

This section summarizes the future annual costs to operate and maintain the groundwater monitoring and containment systems including the enhancements to those systems as discussed in Sections 7.1.1.3. The estimated future costs include the operation of the new pumping well to be installed near SW-10A, even though this well will not be operated unless groundwater monitoring results indicate the need for this well to be operated to maintain hydraulic control of nitrogen compounds in this portion of the Site. It has been assumed that the groundwater containment system will be operated for a minimum period of 30 years.

In addition to the estimated annual operating costs, a summary of other maintenance activities that may not occur on a yearly basis but will likely occur several times over the 30-year project life is also provided.

The activities associated with annual operating and monitoring the two interceptor trenches installed in the bedrock unit, the three interceptor trenches installed in the silty clay unit, and the pumping of the wells for the Kansas River Alluvial aquifer (including the proposed new pumping well) include the following:
• Quarterly collection of water level measurements.
• Purging and collecting groundwater samples from groundwater monitoring wells and pumping wells.
• Collecting groundwater samples from the interceptor trenches.
• Analysis of groundwater samples.
• Quarterly reporting.
• Operating and maintaining the groundwater containment system including general pump maintenance and cleaning, flow meter cleaning, and annual pumping well and trench sump cleaning.
• Electrical costs to operate the pumps associated with the system.

The above activities are currently underway and are expected to be performed for a minimum of 30 years. The estimated long-term costs associated with conducting the above activities are $70,400 per year.

In addition to the annual operating costs, other maintenance and equipment replacement activities will likely be required on a periodic basis over the 30-year project life. These activities include the following:

• An allowance for the replacement of recovery wells should well performance decrease to the point the well(s) are no longer effectively maintaining hydraulic control.
• An allowance for the replacement of pumps associated with the groundwater interceptor trenches.
• An allowance for the replacement of pumps associated with the groundwater recovery wells.
• Costs for the installation on one new pumping well near SW-10A and five new monitoring wells.
• An allowance for general monitoring well repair, plugging, and/or replacement over the 30-year project life.
• Final system decommissioning and well abandonment

The estimated long-term costs for these periodic maintenance activities are estimated to be $371,355 over the 30-year project life.

### 7.1.2 Land Application Program

The existing land application program was previously described in Section 7.1.1.2.4 and is a crucial component of the groundwater containment system. It is anticipated that the need for land application (or other disposal method) of nitrogen impacted water will continue for a minimum period of 30 years. The volume of water to be land applied is expected to increase initially because of the increased collection of storm water runoff and collection of groundwater seepage. The volume of storm water collected for land application is anticipated to decline over time as the
storm water quality improves as a result of the implementation of the RAP, and it is likely the land application program will be terminated before the end of the 30-year period.

Groundwater quality is also expected to improve over time as a result of the implementation of the RAP. As the quality of storm water and groundwater improves, variations to the current land application program will be required. As concentrations of nitrogen compounds in the water retained for land application decline, it will become necessary to put higher volumes, perhaps on the order of 5 to 6 equivalent inches of rainfall of water on the agricultural ground in order to achieve the desired fertilizer benefits. However, farm operators will likely not desire to put this high volume of water on the crops. Therefore, at some point in time, it will become necessary to either locate additional ground or reach an agreement with the current farm operators to apply less volume with increased frequency of application.

Additional agricultural land is available on the south side of the Kansas River adjacent to the existing pipeline. However, existing irrigation equipment is not present so application equipment would need to be purchased and modifications to the pipeline would need to be made so that water could be withdrawn from the pipeline. An agreement would have to be entered into with the owners and operators of this farm ground.

Land is also available east of the Site. However, existing irrigation equipment is not present so application equipment would need to be purchased. An existing pipeline extends to the east from the Site to the location of several water supply wells owned by the Trust. It may be possible to utilize this pipeline to transport water to fields. An agreement would have to be reached with the owners and operators of this farm ground.

It is highly likely that a point in time will be reached when the land application for beneficial use of the nitrogen compounds in the water will no longer be economically feasible due to lower nitrate concentrations and the resultant increase in water volumes required to deliver the desired mass of nitrogen.

Future management of the land application program will require ongoing operations and maintenance associated with the equipment, management of the distribution of the water, and reporting to KDHE and KDA as required by permits.

7.1.2.1 Summary of Annual Costs of Operation for Land Application System

This section summarizes the future annual costs to operate and maintain the land application program. It has been assumed that the land application program will be operated for a minimum period of 30 years.

In addition to the estimated annual operating costs, a summary of other maintenance activities that may not occur on a yearly basis but will likely occur several times over the 30-year project life is also provided.
The activities associated with annual operating and monitoring of the land application program include the following:

- Sampling of the water contained for the program to determine nitrogen compound concentrations to aid in determining the volume of water to apply to achieve the desired fertilizer benefit.
- Analysis of water samples
- Coordination with owners/operators on when to supply water.
- Operation of the pumps to transfer the water to the irrigation systems.
- Annual soil sampling of the agricultural fields to assist in determining future fertilizer needs.
- Annual report preparation.
- Transfer of impacted water from the Overflow Pond to the ASTs.
- Electrical costs to operate the pumps associated with the system.
- Diesel costs to operate transfer pump.
- General maintenance on pumps and piping.

The above activities are currently underway and are expected to be performed for a minimum period of 30 years. The estimated long-term costs for the 30 years are $50,100 per year. A volume of 24 million gallons per year is estimated for the entire 30-year period.

In addition to the annual operating costs, other maintenance and equipment replacement activities will likely be required on a periodic basis over the 30-year project life. These activities include the following:

- An allowance for the replacement of the pump in the Dam Pond Sump.
- An allowance for the maintenance/repair of the main electrical pumps used to pump water north to the fields.
- An allowance for the maintenance/repair of the diesel transfer pump.
- An allowance for maintenance/repair of the center pivot irrigation systems
- Installation of infrastructure and purchase of application equipment necessary to land apply water to farm ground immediately north and to the east of the Site.
- Final system decommissioning

The estimated long-term costs for these periodic maintenance activities are estimated to be $575,600 over the 30-year project life.

### 7.1.3 Land Use Restrictions

The third remedial priority involves the use of land-use restrictions (LURs) to control certain activities and uses of the Site. The LURs will prevent the movement of impacted soils or
extraction of impacted groundwater without proper management. A soil management plan will be
developed and available to future users of the property to provide guidance in the handling and
movement of potentially contaminated soil. The Trustee will apply to KDHE’s Environmental Use
Control Program for LURs identified in this RAP.

LURs are proposed for:

a. Use on areas of the Site where contamination is present above one or more RSK
   standards, but contamination is considered to be minor based on concentrations
   and/or lateral extent of contamination, and no active remedial measures were
   evaluated or proposed;

b. Use on areas of the Site for where active remedial measures were evaluated and
   LURs are the preferred remedial option;

c. Use on all areas of the site and deemed as “Site-wide” LURs.

Because of the large volume of soil impacted by former plant operations, the relative lack of
health risks associated with nitrogen compounds at the Site, and limited financial resources
available for remediation, significant areas of the Site will be addressed through the application of
LURs. An evaluation of remedial options was completed for these impacted soil areas to
demonstrate the practicality of the proposed land-use restrictions. This section provides the
evaluation of remedial alternatives for areas of the Site in which LURs were determined to be the
preferred remedial alternative for surface and subsurface nitrate and ammonia soil impacts above
the respective RSK remediation standards.

For areas with negligible extent and low concentrations of nitrogen compounds or metals, full
remedial alternative evaluation or active remediation was not warranted. This section also
discusses how these areas can be most efficiently managed by use of LURs.

7.1.3.1 Part of Area F – Southeast Site Area

Area F is located in the southeast Site area and consists of approximately 90 acres of grasslands,
shrubs, and natural drainage features. This area is bordered to the south by Highway K-10 and
to the east by an industrial park. This area has not been used in the past for Site Operations.
The location of Area F is illustrated on Figure 5-1.

As part of the Site Characterization activities performed in 2005, soil samples were collected from
29 soil boring and 14 sediment locations across Area F and analyzed for nitrogen compounds
and RCRA metals. Analytical results were obtained from 58 soil samples analyzed for nitrogen
compounds and 3 samples analyzed for RCRA metals. Nitrate plus ammonia concentrations
were no greater than 448 mg/kg in subsurface soil and no greater than 1,704 mg/kg in sediment
in an ephemeral drainage (soil pathway RSK standard = 40 mg/kg nitrate plus ammonia in
subsurface soil; 200 mg/kg nitrate plus ammonia in surface soil). Nitrate plus ammonia
concentrations exceeded the RSK standard in several samples along the western edge of Area F
and in the ditch delineating the northwest border of the area; however, the extent appears to be
limited. Arsenic, barium, chromium and lead were detected but were at concentrations less than
the applicable non-residential RSK standard. Concentrations of cadmium, mercury, selenium, and
silver were not detected at levels above the analytical method detection limit. Additional investigation conducted by KDHE in 2008 identified areas of buried material in the western extent of Area F.

It is recommended that no additional action be required for the south and eastern two-thirds of Area F, with the exception of existing LURs for areas of buried material and Site-wide LURs. The northwestern and western portions comprising of 22 acres in Area F will require specific LURs limiting future excavation and management of soil and buried material, in addition to Site-wide LURs. No additional remedial action was evaluated for this area as the contamination was limited and seemed to be confined to areas of buried material.

It has been demonstrated through long-term monitoring and site characterization activities that the groundwater in Area F will ultimately migrate to the north end of the Site and be captured by the existing groundwater containment system. The area will also fall under the Site-wide LUR which will prohibit the installation of water wells on the Site and limiting residential zoning at the Site.

7.1.3.2 Area D – Paint Shop Area

The former Paint Shop Area is located near the northeast corner of Area D and was used for the storage of paints and solvents, as well as the storage of used oil. The location of the Paint Shop Area is illustrated on Figure 5-1. As part of the Site Characterization activities performed in 2005, soil samples were collected from 10 soil boring locations in the Paint Shop Area and analyzed for nitrates, ammonia, RCRA metals and VOCs.

Arsenic was detected in the surface soil at concentrations no greater than 22.1 mg/kg, which is greater than the residential soil RSK standard of 11.0 mg/kg but less than the non-residential soil standard of 38.0 mg/kg. The area of elevated arsenic appears to be localized. Concentrations of nitrate and ammonia in surface soil were found to be less than the KDHE RSK standard for nitrogen compounds. Barium, cadmium, chromium and lead were detected but not above KDHE non-residential RSK standards. Concentrations of mercury, selenium, and silver were not detected in the surface soil at levels above the analytical method detection limit.

Volatile organic compounds (VOCs) in the surface soil were detected at concentrations below soil and soil to groundwater standards for both residential and non-residential settings for the following: acetone, MEK, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1-methylethylbenzene, ethylbenzene, x,p,o-xylene, n-butylbenzene, n-propylbenzene, p-cymene, sec-butylbenzene, and tetrachloroethylene (“PCE”). The remaining constituents and samples were reported below laboratory detection limits. For more information refer to the 2005 Site Characterization Report.

Nitrate and ammonia were detected as high as a 17.1 mg/kg and 105 mg/kg in the subsurface soil samples collected in the Paint Shop Area which is slightly above the KDHE RSK standard for subsurface soil. VOCs were also detected in the subsurface soil at concentrations below soil and soil to groundwater standards for both residential and non-residential settings for the following: acetone, MEK, and PCE. Groundwater was not encountered during the site investigation in the Paint Shop Area. Additional investigation conducted by KDHE in 2008 confirmed the previous findings.
Additional information on this area of the Site is provided in the 2006 Site Characterization Report.

No additional remedial action is recommended for the Paint Shop section of Area D based on the limited magnitude and extent of contamination in subsurface soils and the lack of groundwater in that area. Potential exposures to the subsurface soil contamination will be managed using LURs. The Paint Shop area consists of approximately 6 acres.

7.1.3.3. Area D – Boiler Furnace/Fuel Oil Storage Area and Old Ammonia Plant

The Boiler Furnace Area, Fuel Oil Storage Area and the Old Ammonia Plant are located near the southern section of Area D. Fuel oil was burned in the boiler furnaces and the fuel oil was stored in aboveground tanks located just south of the furnaces. The Old Ammonia Plant was utilized to produce ammonia and consisted of large diesel compressors that contained oil, as well as using diesel as a fuel source. The location of the subject areas are shown on Figure 5-1.

As part of the Site Characterization activities performed in 2005, soil samples were collected from 11 soil boring locations in the Boiler Furnace Area and Fuel Oil Storage Area and ten boring locations at the Old Ammonia Plant. Soil samples collected in the Boiler Furnace and Fuel Oil Storage Area were analyzed for TPH and RCRA metals. Soil samples collected at the Old Ammonia Plant were analyzed for TPH, RCRA metals, nitrates, ammonia and PCBs.

TPH as fuel product was detected in the surface soil at the Boiler Furnace and Fuel Storage Area but at levels below the KDHE residential RSK standard. Arsenic, barium, cadmium, chromium, mercury, and silver were detected but not above KDHE residential RSK standards. Concentrations of selenium were not detected in the surface soil at levels above the analytical method detection limit.

As fuel product was also detected in the subsurface soil as high as 470 mg/kg, which is below both the residential and non-residential RSK standard for TPH as a diesel range organics. Concentrations of nitrate and ammonia in surface soil were found to be as high as 137 mg/kg and 15.0 mg/kg, respectively, at the Old Ammonia Plant which is above the RSK Standard of 85 mg/kg. Arsenic was detected in the surface soil at concentrations up to 25.5 mg/kg, which is greater than the residential soil RSK standard of 11.0 mg/kg but less than the non-residential soil standard of 38.0 mg/kg. Barium, chromium, lead and mercury were detected but not above KDHE residential RSK standards. Concentrations of cadmium, selenium, and silver were not detected in the surface soil at levels above the analytical method detection limit.

Aroclor 1254 (PCB) was found to be as high as 1.8 mg/kg in the surface soil at the Old Ammonia Plant, below the KDHE residential and non-residential RSK standards. Nitrate and ammonia were detected as high as 30.1 mg/kg and 204 mg/kg, respectively, in the subsurface soil samples collected at the Old Ammonia Plant, which is above the KDHE RSK standard. Groundwater was not encountered during the site investigations at the Boiler Furnace and Fuel Oil Storage Area and Old Ammonia Plant. Additional information on this area of the Site is provided in the 2006 Site Characterization Report.

No additional remedial action is recommended for the Boiler Furnace Area, Fuel Oil Storage Area and the Old Ammonia Plant in Area D based on the limited extent of nitrate, ammonia and arsenic.
contamination in surface soils and nitrate and ammonia in subsurface soils and the lack of groundwater in those areas. Potential exposures to those surface and subsurface soils will be prevented using LURs. The Boiler Furnace Area, Fuel Oil Storage Area and the Old Ammonia Plant sections consists of approximately 18 acres and are depicted in Figure 5-1.

### Area D – Ammonia Production Primary Reform Area

The Ammonia Production Primary Reform Area was utilized to produce ammonia and was used for the storage of paints, solvents and used oil. The area is located near the south central portion of Area D and is illustrated on Figure 5-1. As part of the Site Characterization activities performed in 2005, soil samples were collected from 15 soil boring locations and analyzed for nitrate, ammonia, RCRA metals, TPH as DRO and TPH as GRO. During the 2007 Supplemental Soil Investigation activities, soil samples were collected from three soil boring locations and analyzed for nitrate and ammonia.

During the 2005 Site Characterization, concentrations of nitrate and ammonia in surface soil were found to be as high as 18.5 mg/kg and 213 mg/kg, respectively, which is above KDHE’s RSK standard of 85 mg/kg in surface soil. Arsenic was detected in the surface soil at concentrations up to 31.0 mg/kg, which is greater than the residential soil RSK standard of 11.0 mg/kg but less than the non-residential soil standard of 38.0 mg/kg. Barium, cadmium, chromium, lead and silver were detected but not above KDHE RSK standards. Concentrations of mercury and selenium were not detected in the surface soil at levels above the analytical method detection limit. Concentrations of TPH in the surface soil during the 2005 investigation were found to be as high as 18 mg/kg for GRO, which is below the KDHE RSK standard for soil in a non-residential setting. TPH DRO was detected at concentrations up to 4,600 mg/kg (reported as fuel product), which is above the KDHE RSK standard for soil in a residential setting but below the RSK standard for a non-residential setting.

During the 2005 investigation, nitrate and ammonia were detected as high as 262 mg/kg and 1,560 mg/kg, respectively, in the subsurface soil collected in the Ammonia Production Primary Reform Area, above the KDHE RSK standards. Concentrations of TPH in the subsurface soil were found to be as high as 7.7 mg/kg for GRO and 610 mg/kg for DRO (reported as fuel product) which is below the KDHE RSK standard for soil in a non-residential setting.

Groundwater was not encountered during site investigations at the Ammonia Production Primary Reform Area.

No additional remedial action is recommended for the Ammonia Production Primary Reform Area based on the limited magnitude and extent of nitrate and ammonia contamination in subsurface soil. Potential exposure to the subsurface contamination will be prevented using LURs. The Ammonia Production Primary Reform section consists of approximately 4 acres.

### Area D – Nitric Acid Area

This area produced nitric acid that was used during the production of ammonium nitrite. The area is located near the south central portion of Area D and is illustrated on Figure 5-1. As part of the Site Characterization activities performed in 2005, soil samples were collected from 15 soil boring locations.
locations in the Nitric Acid Area and analyzed for nitrate, ammonia, RCRA metals, TPH as DRO and TPH as GRO.

Concentrations of nitrate and ammonia in surface soil were found to be as high as 35.4 mg/kg and 63 mg/kg, respectively, below the KDHE RSK standards. Arsenic, barium, cadmium, chromium, lead, mercury, and silver were detected but not above KDHE RSK standards. Concentrations of selenium were not detected in the surface soil at levels above the analytical method detection limit.

Nitrate and ammonia were detected as high as 806 mg/kg and 90.8 mg/kg, respectively, in the subsurface soil samples collected in the Nitric Acid Area, above the KDHE RSK standards. Concentrations of TPH in the subsurface soil were found to be as high as 140 mg/kg for GRO and 80 mg/kg for DRO (reported as fuel product) below the KDHE residential and non-residential RSK standards for direct exposure to soil.

Nitrate and ammonia were also detected in four shallow groundwater samples at concentrations as high as 21 mg/L for nitrates and 0.83 mg/L for ammonia, which is above the federal drinking water standard of 10 mg/L for nitrate as nitrogen.

Additional information on this area of the Site is provided in the 2006 Site Characterization Report.

Based on the limited extent of nitrate and ammonia in subsurface soils, no additional remedial action is recommended for the former Nitric Acid Area. Potential exposure to the subsurface contamination will be prevented using LURs. The Nitric Acid Area consists of approximately 4 acres.

### 7.1.3.6 Area D – Cooling Towers

The Area D Cooling Towers consist of 14 former cooling towers located within the Ammonia Plant (four towers), Nitric Acid Plant (five towers), Urea Plant (one tower), Ammonia Nitrate Plant (two towers) and Area 300 (two towers). The locations of the former cooling towers are illustrated on Figure 5-1. All former cooling towers have been decommissioned and demolished down to the respective concrete basins.

As part of the Supplemental Soil Investigation activities performed in 2007, soil samples were collected from 26 soil boring locations (total) beneath the former cooling towers and analyzed for RCRA metals and hexavalent chromium. The analytical results of the 51 (total) surface and shallow subsurface soil samples support that this area was not adversely impacted by the former cooling tower operations.

Concentrations of total chrome in surface soils (0 – 8 inch depth) were found to only be as high as 46.2 mg/kg in the surface soils beneath a former cooling tower at Area 300 and only as high as 35.0 mg/kg in the shallow subsurface soils (8 inch – 3 foot depth) beneath a former cooling tower at the Nitric Acid Plant, below the residential and non-residential RSK. The results for hexavalent chromium and the remaining RCRA metals (arsenic, barium, cadmium, lead, mercury, selenium and silver) were unremarkable. Therefore, it is recommended that no additional remedial action be required for the surface and subsurface soil beneath the former cooling towers and that the area be managed using LURs. The combined area of all the cooling tower areas is slightly over one acre.
7.1.3.7 Area D – Urea #2 Area

The Urea #2 Area is located in the northwest portion of Area D and includes the Urea Production Area, Urea Plant, and the Urea Bulk Warehouse (see Figure 5-1). Previous investigations, including the site characterization investigation conducted in 2005 and the supplemental soil investigation conducted in 2007 have identified soil and groundwater containing nitrate-nitrogen and ammonia-nitrogen on and beneath the urea plant. Elevated concentrations of total nitrogen are higher in the subsurface soils near the central portion of the urea plant and in the vicinity of the urea vault. In addition, KDHE collected and field-screened soil samples in September 2008 from several borings in the area of the urea plant and urea bulk warehouse.

Surface Soils

Site characterization data described in Section 3 of this document has shown that ammonia is present in the surface soils (0-8 inch depth) at the former urea plant at concentrations above the RSK standard. Details of the surface soil impacts are provided in the following sections.

Concentrations of ammonia in surface soils were found to be as high as 1,520 mg/kg near the central portion of the Urea Plant. The highest concentrations were generally found in the vicinity of the Urea Production Area. Nitrate plus ammonia concentrations above the RSK standard cover an approximate combined area of 3.2 acres in Area D surface soils. These areas are shown on Figure 7-6.

Risk calculations performed by USEPA (memorandum dated December 1, 2008) have shown that ammonia in soil can pose a risk to human health under certain exposure scenarios. The construction worker scenario resulted in the highest health risk through exposure to ammonia vapors from surface and subsurface soils and the lowest PRG (385 mg/kg). PRGs were also calculated for outdoor industrial worker (4,500 mg/kg) and residential (1,060 mg/kg) scenarios.

Locations of samples collected in this portion of Area D and analytical results are documented in the 2006 Site Characterization Report (see Appendix C), the report of the supplemental soil investigation findings submitted to KDHE on October 25, 2007 (see Appendix C), and in data collected during KDHE supplemental investigation conducted in September-October 2008 (Appendix C).

Remediation of surface soils would mitigate impact to surface water from this area. As such, remediation of approximately 3.2 acres of surface soils within the Urea Plant area is considered. The volume of affected surface soil in this area is approximately 10,500 cubic yards in the upper 2 feet of soil.

Potential remediation options include:

- Excavation and landfiling on-site (in Area B ponds) – Removal of surface soils to a depth of 2.0 feet and replacement with clean fill. Removed soil would be transported to the Area B ponds for disposal, along with impacted soils from other areas of the Site. LURs would be required to prevent removal of top two feet of soil within the footprint of the cap unless for building purposes, to require proper management/disposal of soils excavated for building purposes, and to repair incidental erosion damage within the footprint of the cap.
• Cover with clean fill – Impacted soils remain in place. Existing structures and concrete could remain in place. A minimum of two feet of clean fill and topsoil would be placed over the affected area (3.2 acres). Surface restoration, grading, and erosion control would be conducted as needed to prevent exposure of affected soils. Infrastructure features would be raised to new grade by future property owner. LURs would be required to prevent removal of top two feet of soil within the footprint of the cap unless for building purposes, to require proper management/disposal of soils excavated for building purposes, and to repair incidental erosion damage within the footprint of the cap.

• Maintain existing cover – Utilize existing surface pavement to minimize surface water contact with impacted soil, erosion protection, and existing storm water collection and discharge practices to control environmental impacts. Existing surface pavement in key areas (areas of high subsurface contamination) would be initially repaired to prevent additional migration of contaminants during precipitation events, if necessary. LURs would be required to prevent removal of surface pavement or exposure of subsurface soil to effects of erosion. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil.

Evaluation of Alternatives

As the basis for the evaluation of excavation in portions of the Urea #2 Area, surface soils containing concentrations greater than the surface soil RSK standard discussed in Section 4 were identified as the source removal area. Data collected during the 2005 site characterization and 2007 supplemental investigation indicates impacted surface soils (0-2 foot depth) cover approximately 3.2 acres. Approximately 10,500 cubic yards of impacted surface soil are estimated for the evaluation.

The following surface soil remediation options were identified and evaluated for this area.
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation of surface soils with concentrations above the surface soil RSK standard. Transport and place excavated soils in Area B ponds. Backfill from on-site sources, grade, and seed.</td>
<td>$218,800</td>
<td>o Requires fill and earthwork upon completion to regrade area.</td>
<td>o Eliminates identified &quot;Hot Spot&quot; sources.</td>
</tr>
<tr>
<td></td>
<td>Based on 10,500 cubic yards of soil over approx. 3.2 acres.</td>
<td>o Soil/sediment stability issues in receiving ponds.</td>
<td>o Can be completed in a relatively short time frame (i.e. months).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Possible insufficient available volume in on-site ponds.</td>
<td>o Allows for more flexible future land use.</td>
</tr>
<tr>
<td>Cover affected area with 2' of clean fill from on-site source, install erosion control and drainage structures, and grade and seed surface.</td>
<td>$108,000</td>
<td>o Requires maintenance of erosion control and drainage features.</td>
<td>o No soil disposal issues on-site or off-site.</td>
</tr>
<tr>
<td></td>
<td>Based on 3.2-acre area covered.</td>
<td>o Existing structures which are not removed would no longer be at grade.</td>
<td>o Can be completed in a relatively short time frame (i.e. months).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o Lower cost.</td>
</tr>
<tr>
<td>Maintain existing pavement or ground-cover over highly contaminated areas and current activities for management of runoff water.</td>
<td>$90,000 over 30 years to maintain in existing condition.</td>
<td>o Provides no improvement to surface soil, subsurface soil, or groundwater.</td>
<td>o Low cost.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Existing surface cover may require repairs to maintain adequate cover.</td>
<td>o NPDES discharge limits are currently being met without performing remedial action in this area.</td>
</tr>
</tbody>
</table>

The excavation alternatives evaluated above require removal of existing concrete and relocation of essential utilities before remedial action can commence. The covering option would require removal of existing buildings and other structures. The cost of these site preparation tasks are not included above.

In the first option, excavated soils would be transported and placed in the Area B ponds that are proposed for capping and closure. Following excavation, earthwork would be required to bring in fill material, re-grade and re-seed the area.

**Preferred Remedial Alternative**

The preferred remedial option for nitrogen impacts in surface soils is to maintain existing pavement in its current condition, and continue current surface water runoff management activities. Nitrogen concentrations would continue to decrease by natural processes and percolation of water through the subsurface. This remedy was selected based on high cost of the other alternatives and the Site’s demonstrated ability to meet surface water discharge limits under the current plant configuration and water management programs.
With this alternative, LURs would be needed to: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) to require proper management/disposal of soils excavated for building purposes; and c) to require repair of incidental damage or weathering of pavement. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil.

Figure 7-6 illustrates the extent of and areas affected by the recommended land use restriction.

**Subsurface Soils**

Site characterization data described in Section 3 of this document have shown that concentrations of total nitrogen are present in subsurface soils within the central portion of the Urea Plant and the south side of the Urea Warehouse at concentrations above RSK standards. Concentrations of total nitrogen in subsurface soils were found to be as high as 10,754 mg/kg near the central portion of the urea plant. Highest concentrations were generally found between the Urea Plant Production Area and the Urea Vault. The waste disposal area identified as the Original Landfill (see Sections 2.2.1 and 3.2.15) is located in the vicinity of the Urea Plant and Urea Vault.

Because of the interest in this area for future redevelopment, only short-term remediation alternatives were considered. Below are two options considered for addressing impacted subsurface soils:

- Excavation and landfiling on-site (Area B ponds) – Removal of subsurface soils that exceed RSK values and replacement with clean fill. Removed soil would be transported to the Area B ponds for disposal, along with impacted soils from other areas of the Site. Only Site-Wide LURs would be required.

- No action – LURs selected for surface soils would be considered appropriate for protection against subsurface soil exposure. Shallow groundwater impacts created by subsurface soils would be captured by continued operation of the existing groundwater system. LURs would be required to prevent removal of existing concrete (unless for building purposes) and to require proper management/disposal of soils excavated for building purposes. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil.

**Evaluation of Alternatives**

As the basis for the evaluation of excavation in portions of the Urea #2 Area, subsurface soils containing concentrations greater than the subsurface soil RSK standard discussed in Section 4 were identified as the source removal area. Data collected primarily during the 2005 site characterization investigation and the 2007 supplemental soil investigation indicates impacted subsurface soils cover, at their maximum extent, approximately 4.4 acres within the central portion of the Urea Plant and Bulk Warehouse. The aerial extent of the affected areas generally decreases with depth.

The depth of impacted soil above the RSK subsurface standard extends to the bedrock surface (up to 27 feet below grade) within the central portion of the Urea Plant and to 9 feet below grade.
within the northeast portion of the Ammonia Plant, located south of the Urea Plant. Approximately 77,700 cubic yards of impacted subsurface soil (including the waste contained in the Original Landfill) are estimated beneath the Urea Plant.

The following subsurface soil remediation options were evaluated for this area.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation of subsurface soils with concentrations above RSK standard. Transport and place excavated soils in Area B ponds. Backfill from on-site sources, grade, and seed.</td>
<td>$1,567,500</td>
<td>• Not practical due to large volume of soil. • Insufficient space for excavated soil in Area B ponds. • Benefits do not justify cost.</td>
<td>• Reduced impact to shallow groundwater from this area.</td>
</tr>
<tr>
<td>No action on soil. Impacted shallow groundwater is contained within the Site. Application of one or more LURs to mitigate risks of exposure. Continued interception and control of groundwater migration.</td>
<td>No additional cost</td>
<td>• Soil continues to impact groundwater. • Long-term operation and maintenance of groundwater containment system.</td>
<td>• No additional cost. • Continued protection of human health.</td>
</tr>
</tbody>
</table>

In the first alternative, excavated soils would be transported and placed in the Area B ponds that are proposed for capping and closure. The large volume of soil would require redesign of pond closure plans. Following excavation, earthwork would be required to bring in fill material, re-grade and re-seed the area.

**Preferred Remedial Alternative**

The preferred remedial option for nitrogen impacts in the subsurface soils is no action and utilizing the same LURs identified for the surface soils. The evaluation of remedial options for subsurface soils within the urea and ammonia plants is based on the following premises:

- Potential exposures to nitrate- and ammonia-contaminated soils can be prevented with LURs.
- Impacted shallow groundwater in bedrock and overburden units is contained within the Site and is captured by the existing groundwater control system.

Remediation of subsurface soil is not necessary for several reasons. In particular, future land use of the Site is expected to be non-residential only, and potential exposure to subsurface nitrate and ammonia impacts in soil can be prevented by land-use restrictions. Additionally, subsurface soils will not come into contact with surface water or storm water runoff and will not create an
off-site transport problem. Shallow groundwater beneath Area D is contained within clay-rich overburden or shallow bedrock, and subsurface soil impact to shallow groundwater will be contained within the Site or captured at the Site boundary by the existing groundwater control system (interceptor trenches and pumping wells). Finally, remediation of subsurface soils would likely be infeasible given the depth, distribution, and low permeability of the sediments.

7.1.3.8 Area A – Northeast Production and Bag Warehouse Areas

The eastern and northern portions of Area A are comprised of what formerly had been utilized for nitrate production plants, UAN and nitrate storage tanks, ammonia nitrate processing, nitrate bulk warehouses, the Bag Warehouse, and service roads and railroads spurs. This area of the Site is collectively referred to as the Northeast Production and Bag Warehouse Area. The boundaries of this roughly 30-acre area are not well defined because of the adjacent Sandstone Hill Area and several Area B ponds (see Figure 2-7 and Figure 3-1).

Previous investigations including the site characterization investigation conducted in 2005 and the recent geologic characterization investigation conducted in 2007 have identified soil and groundwater contaminated with nitrate-nitrogen and ammonia-nitrogen on and beneath the nitrate production, warehousing, and UAN storage area (Sandstone Hill) (hereafter collectively referred to as the northeast production area). The nitrogen impacts in the soil in this area are likely the major contributor to the observed storm water runoff impacts in the Area B ponds and shallow groundwater impacts observed in the groundwater interceptor trench and French drain systems.

For a majority of the areas described in this section, remedial alternatives are presented separately for surface soil impacts versus subsurface soil impacts. LURs are presented when the remedial alternative does not actively address contamination to KDHE’s RSK standards.

Surface Soils

Site characterization data described in Section 3 of this document have shown that nitrate and ammonia are present in surface soils and groundwater in the Northeast Production Area at concentrations greater than RSK values discussed in Section 4. Details of the soil and groundwater impacts are provided in the following sections. Locations of samples collected in this portion of Area A and analytical results are documented in the 2006 Site Characterization Report (see Appendix C) and in data collected during KDHE supplemental investigation conducted in September-October 2008 (Appendix C).

Concentrations of total nitrogen in surface soils (samples collected at least partially from the depth range of 0-2 feet) were found to be as high as 12,020 mg/kg in the area immediately northwest of the West Extension Pond and as high as 4,070 mg/kg in the area south of the former Nitrate Warehouse No. 1. Sampling methods used in this area included the depth range of 0.67 to 3 feet, which was included as a surface depth interval for discussion purposes.

Risk calculations performed by USEPA (memorandum dated December 1, 2008) have shown that ammonia in soil can pose a risk to human health under certain exposure scenarios. The construction worker scenario resulted in the highest health risk through exposure to ammonia vapors from surface and subsurface soils and the lowest PRG (385 mg/kg). PRGs were also calculated for outdoor industrial worker (4,500 mg/kg) and residential (1,060 mg/kg) scenarios.
Samples that exceeded the applicable surface soil RSK standard determined in Section 4 cover an area of approximately 25.4 acres for nitrate plus ammonia. Samples that exceeded the subsurface soil RSK standard cover a slightly larger area than surface soils, encompassing more area north of the Bag Warehouse and east of the nitrate warehouse. Subsurface impacts for nitrate plus ammonia greater than the RSK standard cover an area of approximately 28.0 acres. The areas of surface and subsurface soil above the applicable RSK standard are shown on Figure 7-7.

The volume of impacted surface soil in the Northeast Production and Bag Warehouse Area is approximately 82,000 cubic yards. Much of the affected surface soil area is covered by gravel or concrete pavement.

Potential remediation options include:

- Excavation and landfilling on-site (in Area B ponds) – Removal of surface soils to a depth of 2.0 feet and replacement with clean fill. Removed soil would be transported to the Area B ponds for disposal, along with impacted soils from other areas of the Site. LURs would be required to prevent removal of the top two feet of soil within the footprint of the cap unless for building purposes, to require proper management/disposal of soils excavated for building purposes, and to repair incidental erosion damage within the footprint of the cap.

- Cover with clean fill – Impacted soils remain in place. Existing structures and concrete would remain in place. A minimum of two feet of clean fill and topsoil would be placed over affected area (25.4 acres). Surface restoration, grading, and erosion control would be conducted as needed to prevent exposure of affected soils. Infrastructure features would be raised to new grade by future property owner. LURs would be required to prevent the removal of top two feet of soil within the footprint of the cap unless for building purposes, to require proper management/disposal of soils excavated for building purposes, and to repair incidental erosion damage within the footprint of the cap.

- No additional action taken – Utilize existing surface pavement to minimize surface water contact with impacted soil, erosion protection, and existing storm water collection and discharge practices to control environmental impacts. If no additional action is taken LURs are required to prevent removal of surface pavement or exposure of subsurface soil to effects of erosion. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil.

Evaluation of Alternatives

As the basis for the evaluation of excavation in portions of the Northeast Production Area, surface soils containing concentrations greater than the surface soil RSK standard discussed in Section 4 were identified as the source removal area. Data collected primarily during the 2005 site characterization investigation indicates impacted surface soils (0-2 foot depth) cover approximately 25.4 acres in the area of the Site. Approximately 82,000 cubic yards of impacted surface soil are estimated for the evaluation.
The following surface soil remediation options were identified and evaluated for this area.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation of surface soils with concentrations above the surface soil RSK standard. Transport and place excavated soils in Area B ponds. Backfill with clean fill from on-site source, grade, and seed.</td>
<td>$1,709,850</td>
<td>o Area B ponds do not have sufficient available volume for this amount of soil. o Requires fill and earthwork upon completion to regrade area. o Soil/sediment stability issues in receiving ponds. o Does not include cost of removal of existing concrete pavement and railroad spurs.</td>
<td>o Removes large source of surface water runoff impacts. o Can be completed in a relatively short time frame (i.e. months). o Allows for more flexible land use upon completion.</td>
</tr>
<tr>
<td>Cap affected area with 2’ of clean fill from on-site source; install erosion control and drainage structures, and grade and seed surface.</td>
<td>$855,820</td>
<td>o Requires maintenance of erosion control and drainage features. o Eliminates existing roads and railroad spur. o Existing buildings which are not removed would no longer be at grade. o Requires on-going maintenance of capped area.</td>
<td>o No soil disposal issues on-site or off-site. o Can be completed in a relatively short time frame (i.e. months). o Lower cost than soil removal and replacement.</td>
</tr>
<tr>
<td>Application of one or more LURs to maintain existing pavement or ground-cover and continue current activities for management of runoff water.</td>
<td>No additional cost beyond what is included under storm water O&amp;M budget. Dependent on continuation of land application program.</td>
<td>o Provides no improvement to surface soil, subsurface soil, or groundwater. o Additional action may be required if land application program is discontinued, depending on timing and property development.</td>
<td>• Low cost. • NPDES discharge limits are currently being met without performing remedial action in this area.</td>
</tr>
</tbody>
</table>

The excavation alternatives evaluated above require removal of existing buildings and concrete and relocation of essential utilities before remedial action can commence. The capping option would require removal of existing buildings and other structures. The cost of these site preparation tasks are not included in the remediation estimates above.
In the first option, excavated soils would be transported and placed in the Area B ponds that are proposed for capping and closure. Following excavation, earthwork would be required to bring in fill material from borrow areas on-site, re-grade and re-seed the area.

In addition to the above active remediation alternatives for soils in the Northeast Production Area, the implementation of the following LURs to mitigate the risk of human exposure to impacted surface and subsurface soils were considered:

- Establish an LUR that restricts the excavation of soils from the identified areas impacted to levels above the RSK standards.
- Establish an LUR that notifies future land owners that excavation of soil in identified impacted areas will require management of the soils as nitrogen-impacted waste in accordance with applicable regulations.

Preferred Remedial Alternative

The preferred remedial option for nitrogen impacts in surface soils is to take no additional action, maintain existing pavement, and continue current surface water runoff management activities. Reduction of nitrogen concentrations would continue to decrease by natural processes and percolation of water through the subsurface. This remedy was selected based on high cost of the other alternatives and the Site’s demonstrated ability to meet surface water discharge limits under the current plant configuration and water management programs.

With this alternative, LURs will be needed to: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) require proper management/disposal of soils excavated for building purposes; and c) require repair of incidental damage or weathering of pavement. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil.

Figure 7-7 illustrates the extent of and areas affected by the recommended land use restrictions.

Subsurface Soils

Site characterization data described in Section 3 of this document have shown that nitrate and ammonia are present in subsurface soils in the Northeast Production Area at concentrations greater than RSK values discussed in Section 4.

Concentrations of total nitrogen in subsurface soils (greater than 2 foot depth) were found to be as high as 23,130 mg/kg in the area immediately northwest of the West Extension Pond and as high as 10,440 mg/kg in the former Nitrate Plant No. 2 area. Impacts of total nitrogen in excess of the RSK standard extend to bedrock in many places and to depths up to 31 feet below grade. The highest concentrations were generally found in the areas between the former nitrate plants and three former nitrate warehouses.

Risk calculations performed by USEPA (memorandum dated December 1, 2008) have shown that ammonia in soil can pose a risk to human health under certain exposure scenarios. The construction worker scenario resulted in the highest health risk through exposure to ammonia vapors from surface and subsurface soils and the lowest PRG (385 mg/kg). PRGs were also calculated for outdoor industrial worker (4,500 mg/kg) and residential (1,060 mg/kg) scenarios.
Because of the interest in this area for future redevelopment, only short-duration remediation solutions were considered. Below are two options considered for addressing impacted subsurface soils:

- **Excavation and landfilling on-site (Area B ponds)** – Removal of subsurface soils that exceed the RSK standard and replacement with clean fill. Removed soil would be transported to the Area B ponds for disposal, along with impacted soils from other areas of the Site. Only Site-wide LURs would be required as contaminated soil would be removed to non-residential standards.

- **No additional action taken** – Utilize existing surface pavement to minimize surface water contact with impacted soil, erosion protection, infiltration to groundwater, and existing storm water collection and discharge practices to control environmental impacts. If no additional action is taken LURs are required to prevent removal of surface pavement or exposure of subsurface soil to effects of erosion. Future development of the area would be subject to these restrictions or to development of alternative methods for management or remediation of contaminated soil. Shallow groundwater impacts created by subsurface soils would be captured by continued operation of existing groundwater system.

**Evaluation of Alternatives**

As the basis for the evaluation of excavation in portions of the Northeast Production Area, subsurface soils containing concentrations greater than the subsurface soil RSK standard discussed in **Section 4** were identified as the source removal area. Data collected primarily during the 2005 site characterization investigation indicate impacted subsurface soils (greater than 2 foot depth) cover approximately 28.0 acres of the Site.

The volume of subsurface soil in the Northeast Production and Bag Warehouse Area is more difficult to estimate since the depth of soil overburden above the bedrock is highly variable across the area, ranging from less than 1 foot at the base of the Sandstone Hill to greater than 50 feet along the edge of the railroad right-of-way north of the area, although samples for nitrogen analysis were not collected below 31 feet. In most sample locations, total nitrogen concentrations exceed the subsurface RSK standard throughout the sampled thickness of overburden soils. Using an estimated average impacted subsurface soil thickness of 20 feet across the area of interest, the calculated volume of impacted subsurface soil is approximately 908,000 cubic yards.

The following subsurface soil remediation options were evaluated for this area.
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation of subsurface soils with concentrations above RSK values. Transport and place excavated soils in Area B ponds. Backfill, grade, and seed surface.</td>
<td>$18,237,000 Based on 908,000 cubic yards of soil – 28 acres at average depth of 20 feet,</td>
<td>o Not practical due to large volume of soil. o Insufficient space for excavated soil in Area B ponds. o Not possible due to high costs. o Benefits do not justify cost.</td>
<td>o No further impact to shallow groundwater from this area. o Would reduce or eliminate need for shallow groundwater containment system.</td>
</tr>
<tr>
<td>No action on soils. Application of one or more LURs to mitigate risks of exposure. Continued interception and control of groundwater migration.</td>
<td>No additional cost based on continued operation of groundwater system.</td>
<td>o Long-term operation and maintenance of groundwater containment system.</td>
<td>o Low cost o Provides protection of human health.</td>
</tr>
</tbody>
</table>

With the first alternative, excavated soils would be transported and placed in the Area B ponds that are proposed for capping and closure. The large volume of soil would require redesign of pond closure plans. Following excavation, earthwork would be required to bring in fill material, re-grade the area, and re-seed the area.

**Preferred Remedial Alternative**

The preferred remedial option for nitrogen impacts in the subsurface soils is no action and utilizing the same LURs identified for the surface soils. Active remediation of subsurface soil is not recommended for several reasons. Specifically, future land use of the Site is expected to be non-residential use only, and potential exposure to subsurface nitrate and ammonia impacts can be prevented by land-use restrictions. Additionally, subsurface soils will not come into contact with surface water or storm water runoff and will not create an off-site transport problem. Subsurface soil impact to shallow groundwater will be contained within the Site or captured at the Site boundary by the existing groundwater control system (interceptor trenches and pumping wells). Finally, remediation of subsurface soils would likely be infeasible given the depth, distribution, and low permeability of these sediments.

7.1.3.9 *Groundwater-Contaminated Areas Recommended for LUR-Only Action*

Because of the nature of the shallow water-bearing units over most of the Site (including low permeability, limited quantity and quality), the documented migration of shallow groundwater toward the existing groundwater containment system at the north end of the Site, and because of the limited financial resources available for remediation, shallow groundwater will generally be addressed through the application of LURs rather than by active remediation. Nevertheless, an evaluation of remedial options was completed for these impacted groundwater areas to demonstrate the practicality of the proposed institutional controls. Groundwater impacts in the CRS Unit are discussed separately in **Section 7.1.4.**
7.1.3.9.1 **Area A – Northeast Production Area**

An investigation of shallow groundwater focused on the Northeast Production Area has not been conducted. However, several wells for general shallow groundwater monitoring were installed within the area and are currently included in the groundwater monitoring program. Sampling of these wells during the 2005 Site Characterization demonstrated that nitrate concentrations up to 3,820 mg/L and ammonia concentrations up to 2,740 mg/L are present in the silty clay groundwater unit beneath the Northeast Production Area.

A French drain system constructed for shallow groundwater interception exists along the north edge of the Site. This drain system intercepts shallow groundwater migrating from the Northeast Production Area before it reaches the alluvial aquifer beneath the Kansas River floodplain.

Below are options considered for addressing impacted shallow groundwater:

- Extraction wells and surface discharge – Installation of extraction wells in affected areas and treatment of effluent water using ion exchange and surface discharge.
- Extraction wells and land application – Installation of extraction wells in affected areas and storage of water for future land application.
- Interception at north property boundary (existing system) – Continued operation of French drain groundwater interception system.

Site-wide LURs would be required for all proposed alternatives to prohibit the installation of drinking water wells for public and domestic purposes.

**Evaluation of Alternatives**

The evaluation of remedial options for shallow groundwater in the Northwest Production Area is based on several important premises:

- Shallow groundwater in the overburden and bedrock will not produce a sustainable yield of groundwater.
- Site-wide shallow groundwater flow is toward the north and exits the Site along the north property boundary.
- Existing groundwater interception systems are effective in preventing migration of shallow groundwater to the alluvial aquifer beneath the floodplain.

The following groundwater remediation options were identified and evaluated for this area.
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Extraction wells, ion exchange treatment, and surface discharge       | $800,000 (installation and startup only) | o Requires well installation and maintenance.  
o Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
o High cost of treatment system and O&M.  
o On-going discharge monitoring. | o Would increase rate of impacted groundwater removal relative to existing system alone.  
o Real-time monitoring of progress possible. |
| Extraction wells and land application                                | $100,000                 | o Requires well installation and maintenance.  
o Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
o Long-term suitability for land application not certain. | o Land application infrastructure already in place.  
o Beneficial reuse of fertilizer contamination |
| Maintain existing groundwater interception system at north end of Site | No additional cost based on continued operation of groundwater system. | o Long-term commitment to maintaining French drain and land application systems. | o Low cost.  
o No additional infrastructure required. |

**Preferred Remedial Alternative**

Shallow groundwater in the Northeast Production Area of Area A is contained within silty clay sediments. For this reason, direct ingestion of or exposure to shallow groundwater is not considered a significant risk because groundwater is of very limited quantity and quality. Therefore, active remediation of shallow groundwater in Area A is not recommended. Shallow groundwater which migrates out of Area A will eventually be captured by the groundwater containment system in place at the north edge of the Site (see Section 7.1.1.2).

The preferred remedial alternative for shallow groundwater in Area A, Northeast Production Area, is the continued operation, maintenance, and monitoring of the existing interceptor trenches, French drain, and pumping wells. Shallow groundwater migrates under natural groundwater flow conditions to the existing interceptor trenches and French drain system. Intercepted groundwater is pumped to an above-ground storage tank for future land application.

Further protection against exposure to impacted groundwater will be accomplished by the establishment of Site-wide LURs.
7.1.3.9.2 Area A - Sandstone Hill Shallow Groundwater

Ponds used for the storage of concentrated ammonium nitrate water formerly existed on the west half of Area A in the approximate location of the existing 6,000,000-gallon above ground storage tank (formerly used to store UAN; currently used to store land application water). Before the early 1970’s, the area immediately west of the existing above ground storage tank was the site of several terraced evaporation ponds. The former Concentrate Ponds held process waste streams and storm water runoff from the urea production and ammonium nitrate areas. These ponds were also temporarily used to store UAN, and a smaller pond was used to store neutralizer condensate. The ponds were removed in 1988.

The ponds are included in the area referred to as the Sandstone Hill (see Figures 2-7 and 3-1). The Sandstone Hill is comprised of unevenly bedded soft sandstone with interbedded shale and siltstone between 19 and 33 feet thick, capped by 4 to 6 feet of silt and clay overburden and underlain by a thinly-bedded shale unit.

Previous investigations including the site characterization investigation conducted in 2005 and the recent geologic characterization investigation conducted in 2007 have identified soil and groundwater containing nitrate-nitrogen and ammonia-nitrogen on and beneath the Sandstone Hill. The observed nitrogen concentrations in the soil on the Sandstone Hill are likely the major contributor to the observed groundwater impacts in the hill area. These concentrations are also likely contributing to impacts to surface water through direct runoff from the area and through observed shallow groundwater, which becomes surface water through several seeps identified in the area of the Sandstone Hill. These soil impacts are further discussed in Section 7.3.1, Secondary Remedial Priorities.

Site characterization data described in Section 3 of this document have shown that nitrate and ammonia are present in soils and groundwater in the Sandstone Hill/Concentrate Ponds area at concentrations greater than RSK standards. Details of the soil and groundwater impacts are provided in the following sections. Locations of samples collected in this portion of Area A and analytical results are documented in the 2006 Site Characterization Report (see Appendix C).

The investigation of shallow groundwater in the Sandstone Hill and Concentrate Ponds area has been conducted in several phases since the 1970’s (Woodward-Clyde, 1975). A comprehensive geologic evaluation of the Sandstone Hill was completed in 2007 with the objective of better defining the occurrence of nitrate and ammonia in groundwater. The 2007 investigation focused on determining the flow paths and potential hydraulic connection of strata within the Sandstone Hill and evaluation of their relation to groundwater seeps observed on the Sandstone Hill. Concentrations observed in groundwater seeps were found to be higher than shallow groundwater concentrations in samples taken from water-bearing zones in the sandstone formation, leading to the conclusion that groundwater seeps may be reflective of higher concentrations observed in surface and subsurface soils.

Two shallow groundwater interceptor trenches with sumps exist along the north side of the Sandstone Hill. These trenches intercept shallow groundwater migrating from the northeast side of the Sandstone Hill and the production areas on the east flank of the Sandstone Hill.
groundwater also exits the Sandstone Hill through surface seeps, which drain as surface water from the Hill.

Evaluation of Alternatives

The evaluation of remedial options for shallow groundwater in the former Concentrate Ponds and Sandstone Hill area is based on several important premises:

- Shallow groundwater in the overburden and bedrock will not produce a sustainable yield of groundwater.
- Site-wide shallow groundwater flow is toward the north and exits the Site along the north property boundary.
- Existing groundwater interception systems are effective in preventing migration of shallow groundwater to the alluvial aquifer beneath the floodplain.

The following groundwater remediation options were identified and evaluated for this area.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Extraction wells, ion exchange treatment, and surface discharge | $800,000 (installation and startup only) | - Requires well installation and maintenance.  
- Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
- High cost of treatment system and O&M.  
- On-going discharge monitoring. | - Would increase rate of impacted groundwater removal relative to existing system alone.  
- Real-time monitoring of progress possible. |
| Extraction wells and land application | $100,000 | - Requires well installation and maintenance.  
- Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
- Long-term suitability for land application not certain as concentrations decrease over time. | - Land application infrastructure already in place.  
- Beneficial re-use of nitrogen compounds for fertilizer value. |
### Method

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Plant Poplar trees and Switchgrass to enhance phyto-remediation of nitrogen concentrations in the shallow groundwater. Estimate approximately 300 hybrid Poplar trees and Switchgrass. Includes 5 years of monitoring and maintenance. | $587,600 Based on application over approx. 11.2 acres. | - 5 to 10 year timeframe.  
- Will require site preparation for planting.  
- Will require irrigation to establish plant growth which could increase flow from seeps and mobilize more nitrate and ammonia into surface water.  
- Loss of use of the treatment area for the duration of remediation.  
- Harvesting of Switchgrass required. | - Improves property by planting vegetation.  
- Potentially addresses deeper seeps.  
- Improves surface water runoff quality.  
- Provides good public relations and university research opportunities.  
- Requires no major earthwork.  
- Allows for eventual unrestricted land use. |
| Maintain existing groundwater interception system at north end of Site. | No additional cost based on continued operation of groundwater system. | - Long-term commitment to maintaining French drain and land application systems. | - Low cost.  
- No additional infrastructure required.  
- Beneficial re-use of nitrogen compounds for fertilizer value. |

### Preferred Remedial Alternative

Active remediation of shallow groundwater within the Sandstone Hill and former Concentrate Pond area will not be conducted. Groundwater detected in the overburden and shallow bedrock of Area A migrates down gradient toward the north and northeast. However, the existing groundwater containment system of interceptor trenches, French drain, and pumping wells prevents migration into the alluvial aquifer system associated with the floodplain of the Kansas River. The Central Ponds Trench is an enhancement to the groundwater containment system that will help control the migration of groundwater seeping from the south side of Sandstone Hill (see Section 7.1.1.3.2). Further protection against exposure to impacted groundwater will be accomplished by the establishment of Site-wide LURSs.

### 7.1.3.9.3 Area D – Operations Area

Shallow groundwater was encountered in the overburden and bedrock at ten locations during the 2005 site characterization investigation conducted at the Urea and Nitric Acid Plants. Shallow groundwater was not encountered at the Ammonia Plant during the 2005 investigation. Analyses of the shallow groundwater encountered at the Urea Plant indicated nitrate concentrations up to 299 mg/L and ammonia concentrations up to 2,780 mg/L. Analyses of shallow groundwater encountered at the Nitric Acid Plant indicated nitrate concentrations up to 21 mg/L and ammonia concentrations up to 0.83 mg/L. Maps in the 2006 report on site characterization activities depict groundwater concentrations encountered (see Appendix C).
Shallow groundwater within Area D eventually migrates to the north and is intercepted by a French drain system constructed along the northern edge of the Site. This drain system intercepts shallow groundwater before it reaches the alluvial aquifer beneath the Kansas River floodplain.

Below are three options considered for addressing impacted shallow groundwater:

- **Extraction wells and surface discharge** – Installation of extraction wells in affected areas and treatment of effluent water using ion exchange and surface discharge.
- **Extraction wells and land application** – Installation of extraction wells in affected areas and storage of water for future land application.
- **Interception at north property boundary (existing system)** – Continued operation of French drain groundwater interception system.

Site-wide LURs would be required for all proposed alternatives to prohibit the installation of drinking water wells for public and domestic purposes.

**Evaluation of Alternatives**

The evaluation of remedial options for shallow groundwater in the area of the ammonia, urea and nitric acid plants is based on the following premises:

- Site-wide shallow groundwater flow is toward the north and exits the Site along the north property boundary.
- Existing groundwater interception system is effective in preventing migration of shallow groundwater to the alluvial aquifer beneath the floodplain.

The following groundwater remediation options were identified and evaluated for this area.
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Extraction wells, ion exchange treatment, and surface discharge       | $800,000 (installation and startup only) | - Requires well installation and maintenance.  
- Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
- High cost of treatment system and maintenance.  
- On-going discharge monitoring. | - Would increase rate of impacted groundwater removal relative to existing system alone.  
- Real-time monitoring of progress possible. |
| Extraction wells and land application                                | $40,000                              | - Requires well installation and maintenance.  
- Low permeability of sediments likely to produce slow rate of extraction and cleanup.  
- Long-term suitability for land application not certain as concentrations decrease over time. | - Land application infrastructure already in place.                                                  |
| Maintain existing groundwater interception system.                   | No additional cost based on continued operation of groundwater system. | - Long-term commitment to maintaining French drain and land application systems.                                                              | - Low cost.  
- No additional infrastructure required. |

**Preferred Remedial Alternative**

Shallow groundwater within the ammonia, nitric acid and urea plants at Area D is contained within silty clay sediments and groundwater is of limited quantity and quality. For this reason, direct ingestion of or exposure to shallow groundwater is not considered a significant risk. Therefore, active remediation of shallow groundwater in Area D is not recommended. Shallow groundwater which migrates out of Area D will eventually be captured by the groundwater containment system in place at the north edge of the Site (see Section 7.1.1.2).

The preferred remedial alternative for shallow groundwater in Area D, Operations Area, is the continued operation, maintenance, and monitoring of the existing interceptor trenches, French drain, and pumping wells. Shallow groundwater migrates under natural groundwater flow conditions to the existing interceptor trenches and French drain system. Intercepted groundwater is pumped to an above-ground storage tank pending land application.
Further protection against exposure to impacted groundwater will be accomplished by the establishment of Site-wide LURs.

### 7.1.4 Primary Remedial Priority – CRS Unit Monitoring and Closure

The CRS Unit was utilized to remove hexavalent chromium from water, which had been circulated through cooling towers to inhibit corrosion. The system consisted of an unlined ditch, surface impoundment, lined caustic and acid water ponds and a sulfur dioxide storage building. The location of the CRS Unit is illustrated on the Site Map provided as Figure 3-1. Additional information regarding the history of the CRS Unit is presented in Sections 3.2.5, 3.2.6 and 6.15.

The CRS Unit is subject to the RCRA Part B Post Closure Permit that is being enforced by the KDHE Bureau of Waste Management. The following sections present the RCRA Closure and Post-Closure activities conducted at the CRS Unit.

#### 7.1.4.1 Closure Activities

The CRS surface impoundment area consisted of a drainage ditch and holding pond. The water treatment process was no longer being used at the time of closure (1986); therefore, the CRS system was closed as a surface storage impoundment. A Closure Project Certification Report was prepared by Geraghty & Miller, Inc. in January 1987.

Closure activities included the following:

- Sampling and analysis of the soil in the surface impoundment area and ditch.
- Sampling and analysis of the Petromat liner along the side of the pond.
- Removal and disposal of contaminated soil at a hazardous waste disposal facility.
- Petromat liner removal and disposal as non-hazardous waste.
- Construction of an interception trench (French drain) east of the pond and ditch to accelerate removal of contaminated groundwater.

Twelve composite soil samples were collected from the drainage ditch area, 18 composite soil samples were collected from the pond area and four samples of the Petromat liner were collected. All samples were analyzed for total chromium, and 12 soil samples were analyzed for EP toxicity. Results of the total chromium and EP toxicity soil sample analyses showed that chromium concentrations exceeded the action limit of 32 mg/kg, requiring removal of all soil in the ditch bottom down to the underlying sandstone. In the pond area, chromium results indicated that partial soil removal was necessary in 75% of the sampled area. EP toxicity results showed the extractable chromium concentrations to be below the action level of 5 mg/kg.

A total of 496 cubic yards of soil were removed from the ditch (272 cubic yards) and pond (224 cubic yards) areas. All soil was transported to the Peoria Disposal Company site in Illinois. The Petromat liner removed from the pond was found to be non-hazardous and did not require disposal as a hazardous waste.

As noted above, an interceptor trench (French drain) was constructed to intercept the flow and accelerate the removal of shallow groundwater in the area of the CRS Unit. A sump was installed.
near the north end of the French drain to supplement withdrawal of water from the system. The outfall of the drain is in the drainage ditch northeast of the pond area.

### 7.1.4.2 Post-Closure Activities

The CRS Unit was unable to receive clean-closed status because chromium was detected at concentrations above acceptable limits in the groundwater beneath the Site. Therefore, as presented in Section 6.15.3, a RCRA Part B Post Closure Care Permit was issued by the KDHE and USEPA Region VII in February 1993. The scope of the Post Closure Care Permit included corrective action and monitoring of the groundwater beneath the CRS Unit for both chromium concentrations and pH. Since the corrective action and monitoring was implemented, chromium concentrations in groundwater have declined to below the action level. However, the pH of the groundwater is still below the acceptable range in three wells and in the French drain discharge. The CRS Unit continues to be subject to post-closure monitoring pending return of pH conditions in the groundwater to near neutral (between pH of 6 and 9).

To help mitigate the low pH condition, a potable water injection system was constructed in May 2006. The system allowed potable water to flow under natural hydraulic gradient though the CRS Unit subsurface, through the infiltration trench and injection wells, in an effort to accelerate the mitigation of low pH conditions and increase the hydraulic gradient through the site. The system was monitored daily, and pH measurements were recorded weekly.

An amendment to the potable water injection system was installed in June 2007. The amended system included injection of a sodium bicarbonate solution into the potable water stream before distribution to the infiltration trench and injection wells. Sodium bicarbonate has the effect of neutralizing the acidic groundwater more rapidly than straight potable water.

The pH monitoring data accumulated since start-up of the injection system in May 2006 has not shown significant adjustment to neutral conditions, likely because of the low hydraulic conductivity of the water bearing zones. The estimated flow rate of groundwater through the CRS Unit was calculated during the closure investigation to be approximately 20 ft per year on average under natural hydraulic gradient conditions. The area of low pH groundwater is approximately 240 feet long.

To speed the recovery of groundwater pH to near neutral conditions, alternative options for in-situ and/or ex-situ pH adjustment and/or increasing hydraulic conductivity have been evaluated and are presented in the Interim Remedial Measure Plan for the CRS Unit. The Plan includes a description and estimated costs for the following accelerated remedial options:

- Groundwater Recirculation;
- Direct Injection of Neutralizing Agent;
- Excavation and Neutralization; and
- Injection of 5% Sodium Bicarbonate.

On December 28, 2007 the Plan was submitted to KDHE for review. A copy of the Plan is provided in Appendix C.

In correspondence dated February 19, 2008 KDHE requested that a petition be prepared to suspend all Post-Closure Care and monitoring requirements on the CRS Unit based on a
successful clean-up of groundwater for submittal to the KDHE/Bureau of Waste Management. On March 14, 2008 a petition was submitted to KDHE to suspend all Post-Closure Care and monitoring requirements on the CRS Unit. KDHE did not respond to this initial request.

Subsequently, on May 1, 2008, KDHE requested cost estimates to restart the groundwater injection system at the CRS Unit. On May 16, 2008, cost estimates for restarting the groundwater injection system were submitted to KDHE. KDHE evaluated the costs to restart the groundwater injection system at the CRS Unit and determined that the costs were prohibitive for the minimal benefit of neutralizing low pH groundwater.

On October 1, 2008 a request for a final determination on the petition was submitted to KDHE. Included with this request was a proposal that if the petition could not be approved, the monitoring requirements for the CRS unit be reduced. The following reductions were proposed:

- Reduce monitoring from quarterly to semi-annual events on all wells and the French drain discharge with analysis for pH only;
- Reduce reporting requirements to annual reporting only;
- Termination of the underground injection control permit and all associated monitoring and reporting;
- Discontinue the automatic pumping of selected monitoring wells; and
- A waiver of the annual Post-Closure Care permit fee from the remainder of the permit period.

On October 17, 2008 KDHE responded indicating that the petition to suspend all Post-Closure Care monitoring requirements could not be approved. However, a reduction in the monitoring requirements was approved including the following:

- Pumping of selected wells can be discontinued;
- Termination of the UIC permit;
- Reduction of monitoring from quarterly to semi-annual on all wells and the French drain discharge with analysis of pH only.
- Reporting requirements would remain semi-annual coupled with the annual report. However, the semi-annual reports could be reduced to include data only.

It was indicated that the annual Post-Closure Care permit fee could not be waived.

### 7.1.4.3 Revised Post-Closure Care Monitoring and Reporting Schedule

The revised Post-Closure Care monitoring and reporting requirements for the CRS Unit, as approved by KDHE, include semi-annual sampling of all monitoring wells associated with the CRS Unit and the French drain discharge. Samples will be analyzed for pH only. Semi-annual data submittals only will follow each semi-annual event coupled with the annual report. These activities are anticipated to be required for a period of 12 years with estimated costs projected to be $8,000 per year.
In addition to the monitoring costs, the annual Post-Care Closure permit must also be maintained for a period of 12 years. The annual Post-Care Closure permit fee is $10,000. The costs associated with maintaining this permit will be funded from the Administrative Trust.

7.2 PRIMARY DEVELOPMENT PRIORITIES – SURFACE WATER MANAGEMENT

7.2.1 Storm Water Management and NPDES Permit Monitoring Program

Storm water management and monitoring is an important aspect of the overall management of environmental issues at the Site. Storm water exiting the Site is currently discharged through on-site ditches and ponds to the Kansas River. This also includes storm water coming on the Site from the south, including runoff from Highway K-10 as well as from land south of Highway K-10.

The only area of the Site where storm water has been shown to be impacted significantly by nitrogen compounds is in Area A (Sandstone Hill) at the north end of the Site. Area A continues to impact storm water with contact to nitrogen impacted surface soils and nitrogen impacted groundwater that appears at the surface as seeps.

Storm water monitoring data indicates that concentrations in storm water flowing from Area A can range from less than 100 mg/L to greater than 1,000 mg/L nitrate-nitrogen. This range depends on the specific area of runoff, frequency, intensity, and duration of the event, and the path the runoff follows. Storm water data from March 2006 through December 2007 indicates nitrate-nitrogen concentrations ranged from 11 mg/l to 248 mg/L, with an average concentration of 115 mg/L.

The major components of the proposed storm water management system are the desludging of the East and West Effluent Ponds, and the construction of a new storm water drainage ditch, berm, weir structure, and detention basin using a pump to facilitate drainage from the basin. Once desludged, the East and West Effluent Ponds will be combined into the detention basin.

The desludging of the East and West Effluent Ponds was originally evaluated as part of the overall Area B, Northern Ponds Decommissioning Plan. Modifications to the priorities established by KDHE in an August 26, 2008 correspondence were made in an October 15, 2008 KDHE correspondence. The October 15, 2008 modifications included establishing a Primary Development Priority, which includes the modification, operation, and maintenance of the storm water management system at the Site. This modification was made to acknowledge that these activities should be tied in with the future development plans for the Site. Based on the modified priorities, the desludging of the East and West Effluent Ponds will be performed separately from the final closure of the Northern Ponds. However, the scope of work for the East and West Effluent Ponds remains essentially the same as that presented as the preferred alternative in the original Area B, Northern Ponds Decommission Plan evaluation.
Management

It will be necessary to continue to manage and monitor storm water discharge from the site until such time as the East and West Effluent Ponds are desludged and the new storm water drainage ditch is constructed and placed into operation as discussed in Section 7.2.2.2. As these activities are considered to be associated with future redevelopment of the Site, it has been assumed that they will not be completed for a period of at least 5 years to allow for a Site development plan to be prepared and evaluated against the conceptual storm water management structure and design. Therefore, storm water monitoring and NPDES permit monitoring is assumed to be required for a period of approximately 8 years.

Management and monitoring of the storm water will continue as outlined in the Storm Water Management Plan (SMP) submitted to KDHE in 2006 for an assumed period of approximately 8 years. This monitoring consists of sampling storm water runoff during storm events and the analysis of the samples for ammonia-nitrogen and nitrate-nitrogen. The purpose of the sampling and analysis is to determine the impact to storm water from specific areas of the Site and to monitor the effectiveness of interim remedial actions taken.

Storm water will continue to be discharged to the Kansas River through the NPDES permitted outfall. Storm water with concentrations of nitrogen compounds above NPDES limits, primarily from Area A, will be segregated and collected in the Overflow Pond for future use in the land application program after the new storm water drainage ditch and detention basin are constructed and the NPDES permit is no longer in place.

Once the new storm water drainage ditch and detention basin are constructed and, as a result of the segregation of impacted storm water for use in the land application program, storm water monitoring should no longer be required.

Projected Costs

The scope of work associated with the continued implementation of the storm water management and monitoring at the Site is estimated at $21,800 per year. This scope includes the sampling of storm water runoff during storm events, analysis of samples, and reporting and evaluation of the data. This typically occurs approximately 20 times per year. Sampling and analysis for compliance with the NPDES permit is also included. It is assumed storm water monitoring will be required for a period of approximately 8 years until the East and West Effluent Ponds are desludged and the new storm water drainage ditch and detention basin are constructed.

7.2.2 Surface Water Management Infrastructure

The desludging of the East and West Effluent Ponds and the construction of the new storm water drainage ditch are not anticipated to occur until a development plan for the Site has been prepared. The intent is to allow evaluation of the storm water management requirements for the development against the conceptual designs of the new storm water drainage ditch and detention basin to ensure that the structure is sufficient to meet the needs of the development. However, if a development plan has not been prepared within 5 years, these activities will be completed and funded from the Administrative Trust.
7.2.2.1 East and West Effluent Pond Sediments Removal

To facilitate the construction of the new storm water drainage structure, which will utilize the East and West Effluent Ponds as a detention basin, the accumulated sediments must be removed from these ponds.

Before removing the sediments from the ponds, it will be necessary to remove the standing water in the West Effluent, East Effluent, West Lime, and Rundown Ponds. Samples of the water will be obtained and analyzed for nitrogen compounds to assist in the management of this water. During dewatering activities, storm water runoff from non-impacted areas of the Site as well as runoff coming from areas south of the Site will be directed to the effluent ditch. Storm water runoff from impacted areas of the Site will be directed to the Overflow Pond.

A Notice of Intent (NOI) and a construction storm water permit application was submitted in August 2007 addressing the closure of the northern ponds. A revised NOI was submitted on July 2007 to include the sediment removal activities performed on the Overflow Pond discussed in Section 6.9. The amended NOI will be further amended to include the sediment removal activities from the East and West Effluent Ponds.

An Erosion Control Plan will be prepared for the sediment removal activities outlining the best management practices that will be followed to control erosion from normal storm water runoff, pond dewatering activities, and sediment removal activities. The Erosion Control Plan will identify the type of erosion control to be used, placement of erosion control devices, and necessary monitoring of erosion controls to minimize erosion during the activities.

The following sections provide details on the sediment removal activities that will be performed for East and West Effluent Ponds.

West Effluent Pond

The West Effluent Pond appears to have an accumulated thickness of sediments of approximately 4 feet. The sediments are described as brown to gray clay. The native clay at the base of the pond was observed to be dark gray to black. The accumulated sediments will be removed to contact with the underlying native clay. The upper 6 inches of the native clay will also be removed.

An estimated 43,000 cubic yards of material (including 6 inches of native clay base) will be removed from the West Effluent Pond and placed in the consolidation ponds.

Once the material has been removed from the West Effluent Pond, samples of the material remaining in the base of the pond will be collected for analysis of nitrogen compounds (nitrate and ammonia), chromium, and arsenic. Samples will be obtained from three locations within the footprint of the pond to a depth of 9-feet below grade or until groundwater is encountered, whichever comes first. The samples will be collected in one foot intervals. Samples will be collected using a direct-push rig or similar sampling equipment.

Once it has been determined that removal of additional pond base material is not warranted or feasible from the West Effluent Pond, the pond will be restored and become part of the detention basin for the new storm water drainage ditch that is discussed in Section 7.2.2.2.
East Effluent Pond

The East Effluent Pond was found to contain an accumulated thickness of sediments of approximately 5 feet. The sediments are described as olive brown silty clay and greenish gray clay. The native clay at the base of the pond was observed to be black. The accumulated sediment will be removed to the top of the underlying native clay. The upper 6-inches of the native clay will be removed as well.

An estimated 31,300 cubic yards of material (including 6-inches of native clay base) will be removed from the East Effluent Pond and placed in the consolidation ponds.

Upon removal of the material from the East Effluent Pond, samples of the material remaining in the base of the pond will be collected for analysis of nitrogen compounds (nitrate and ammonia), chromium, and arsenic. Samples will be obtained from three locations within the footprint of the pond to a depth of 9-feet below grade or until groundwater is encountered, whichever comes first. The samples will be collected in one-foot intervals. Samples will be collected using a direct-push rig or similar sampling equipment.

Once it has been determined that removal of additional pond base material is not warranted or feasible from the East Effluent Pond, the pond will be restored and become part of the detention basin for the new storm water drainage ditch that is discussed in Section 7.2.2.2.

The costs associated with the removal of sediments (74,300 cubic yards) from the West and East Effluent Ponds and placement in the Rundown and West Lime Pond are estimated at $1,015,412.

7.2.2.2 Storm Water Management Infrastructure

New Storm Water Drainage Ditch

Previously, storm water runoff through the site was managed through the main storm water drainage ditch running south to north through the site and the West and East Effluent Ponds. Storm water runoff managed includes runoff from the site as well as runoff from Highway K-10 and areas to the south of K-10. As a result of the pond closure activities discussed above, a new method for managing non-impacted storm water runoff through the site is required.

Management of non-impacted storm water runoff from the site as well as runoff from south of the Site will be accomplished through the construction of a new storm water drainage structure to be installed along the western edge of the West Effluent Pond. The new storm water drainage structure would be an extension of the existing main storm water drainage ditch.

To evaluate the volume of storm water runoff flowing through the site, LandPlan Engineering, PA of Lawrence, Kansas was contracted to perform a drainage study of the Site. The drainage study provided a conceptual design basis for the new storm water structure that would be required to handle the storm water flow through the site without adversely effecting properties up gradient or down gradient of the site.

Based on the drainage study, an original conceptual design of the new storm water drainage structure was developed. The original design included extending the main storm water drainage ditch through the western edge of the West Effluent Pond. The ditch extension included a lateral weir placed at the upstream end to serve as a diversion feature. The weir diverts excess storm
water flow into a detention basin (former West and East Effluent Ponds) where the water is temporarily stored until flow subsides. Once flow subsides, the water is released by gravity drainage assisted by pumping, as necessary. A copy of the drainage study and conceptual design drawings is provided on the CD in Appendix C.

Three options for the new storm water drainage structure were evaluated.

- **Option A**: Original Design (detention with pump) - This option includes the construction of a drainage ditch, berm, weir structure, and detention basin using a pump to facilitate drainage from the detention basin. Excess flow during storm events is diverted to the detention basin. As a result of the flat elevations in this area with a control point discharge elevation of approximately 818 feet above sea level (asl), an existing drainage structure and pump located between the current West Effluent Pond and East Effluent Pond is proposed to be used to facilitate drainage from the detention basin. No additional fill material is required to construct the detention basin following removal of sediments. A pump is required to facilitate drainage of the detention basin and long-term O&M costs are associated with this option.

- **Option B**: Drainage Ditch with Detention Basin (gravity drainage) - This option includes the construction of a drainage ditch, berm, weir structure, and detention basin similar to Option A. However, Option B is designed to use gravity drainage for the detention basin rather than the pump. Excess flow during storm events is diverted to the detention basin. In order to achieve a minimum grade for gravity discharge (1%), approximately 147,000 cubic yards of fill material will be needed to elevate the base of the detention basin. The minimum grade will likely not be sufficient to maintain vegetative growth in the detention basin area.

- **Option C**: Drainage Ditch with Detention Basin (gravity drainage) - This option includes the construction of a drainage ditch and detention basin. However, this option does not include a berm and weir structure and the drainage ditch is wider. Option C is designed to use gravity drainage for the detention basin rather than the pump. Excess flow during storm events is diverted to the detention pond. In order to achieve a minimum grade for gravity discharge (1%), approximately 139,400 cubic yards of fill material will be needed to elevate the base of the detention basin. The minimum grade will likely not be sufficient to maintain vegetative growth in the detention basin area.

Conceptual design drawings for these three options are provided as Figures 7-8, 7-9, and 7-10, respectively.
<table>
<thead>
<tr>
<th>Design Alternative</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Option A - Original Design (detention with pump) | $687,200        | - Long-term O&M costs associated with pump-assisted discharge (assumed 26 years).  
- Large portion of the former pond area unusable for anything other than potential storm water retention.  
- Discharge pump is manually operated requiring personnel to be available to start and stop the pump as necessary over the 26-year period. | - No additional fill material required.  
- Shorter detention time using pump to assist in dewatering the detention basin.  
- Ability to use existing drainage structure and pump.  
- Pump-assisted dewatering may allow for maintaining vegetative growth by reducing retention time.  
- Settlement of fill is not a major maintenance issue.  
- Least expensive option |
<table>
<thead>
<tr>
<th>Design Alternative</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Option B: Drainage Ditch with Detention Basin (gravity drainage) | $1,150,000 | - Significant volume of fill material (147,000 cy) required to achieve a minimum grade for gravity discharge.  
- Minimum grade will likely not be sufficient to maintain vegetative growth.  
- Longer retention time than with pump-assisted discharge.  
- As a result of nearly flat drainage, any settlement in the substantial fill placed will become a maintenance issue.  
- Large portion of the former pond area unusable for anything other than potential storm water retention.  
- Will require re-running the hydrologic models and could result in design adjustments.  
- Most expensive option. | - Long-term O&M associated with pump-assisted discharge eliminated. |
### Design Alternative

<table>
<thead>
<tr>
<th>Design Alternative</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option C: Drainage Ditch with Detention Basin (gravity</td>
<td>$1,010,000</td>
<td>o Significant volume of fill material (139,400 cy) required to achieve minimum grade for gravity discharge.</td>
<td>o Long-term O&amp;M associated with pump-assisted discharge eliminated.</td>
</tr>
<tr>
<td>drainage)</td>
<td></td>
<td>o Minimum grade will likely not be sufficient to maintain vegetative growth.</td>
<td>o Less expensive than Option B.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Longer retention time than with pump-assisted discharge.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o As a result of nearly flat drainage, any settlement in the substantial fill placed will become a maintenance issue.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Large portion of former pond area unusable for anything other than potential storm water retention.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Will require re-running of the hydrologic models and could result in design adjustments.</td>
<td></td>
</tr>
</tbody>
</table>

### Preferred Alternative

Based on the evaluation of the identified options, Option A has been selected as the preferred option for implementation.

The initial construction of the new storm water drainage structure will commence immediately following the removal of sediments from the West Effluent Pond. Construction of the drainage structure will be performed in conjunction with sediment removal from the East Effluent Pond. The new drainage structure must be completed and operational before the final closure activities of the West Lime, Rundown, and East Lime Ponds are completed at which time the current bypass ditch will be eliminated.

Should additional thickness of native clay base (in excess of the 6-inches planned) be removed from these ponds, it may be necessary to perform a survey of the base of the ponds to determine new base elevations and determine if adjustments in the design of the new storm water drainage
structure are required. Conceptual designs based on the current anticipated conditions are provided in the drainage study report provided on the CD contained in Appendix C.

Upon completion, the non-impacted storm water from areas south of the Site as well as non-impacted storm water runoff from the Site will be directed through the main storm water ditch which includes the newly constructed storm water drainage structure in the western portion of the former West Effluent Pond. Storm water flowing through the Site will exit the Site with ultimate discharge to the Kansas River.

It is anticipated that construction of the new storm water drainage ditch will not be initiated until it has been determined how the Site will be developed. If a development plan is not available after a period of 5 years, construction of the storm water drainage ditch will proceed using Administrative Trust funds. The Site development plan and the design of the new storm water drainage ditch should be evaluated to determine if the current ditch design will accommodate the development of the Site. If other options for routing storm water through the site other than the storm water ditch design presented in the RAP are proposed, the design will need to be detailed in the RD/RA.

7.3 SECONDARY REMEDIAL PRIORITIES

At the direction of KDHE, the Primary Remedial Priorities discussed in Section 7.1 will be completed using the limited Remediation Trust funds. However, other remedial activities have been identified as needed to enhance and expedite the remediation of the Site. As previously discussed, KDHE and EPA prioritized the remedies recommended for the Site based on the limitations of the Trust funding. Primary remedies as described in Section 7.1 will be completed within the limitations of the Remediation Trust funding, and activities associated with Storm Water Management will be addressed within the limitations of the Administrative Trust funding.

Secondary Remedial Priorities are required by KDHE and will be completed either through any remaining funding from the Remediation or Administrative Trusts, through financial assurances obtained by the purchaser of the Site, and/or through funds generated by redevelopment of areas of the Site.

Secondary remedial priorities include the following:

- Sandstone Hill soils
- Central Ponds soils
- Dam Pond sediments
- Krehbiel and West Pond
- Area B Ponds
- Area A soils
- Area D soils
- Production well plugging
- Remedial Design document
7.3.1 Area A – UAN Storage Area (Sandstone Hill) Soils

Area A is comprised of what formerly had been designated as the UAN Storage Area (Sandstone Hill), Ammonium Nitrate Processing Area, Nitrate Production, and Nitrate Bulk Warehousing. This area comprises approximately 78 acres and lies in the north central portion of the property. Interim remedial measures have been performed in Area A on the Central Ponds and ASTs as previously discussed in Section 6.

The evaluation of remedial options for soils in the UAN Storage (Sandstone Hill) area (formerly the location of the Concentrate Ponds) is based on several important premises:

- Surface soils may represent a health risk and a risk to degradation of surface water and groundwater.
- Subsurface soils may represent a health risk and a risk to degradation of groundwater.
- Shallow groundwater in bedrock and overburden units eventually migrates northward and exits the Site along the north boundary, where it is captured by the existing groundwater control system.

As the basis for the evaluation of excavation on the Sandstone Hill, the area of soil containing concentrations above the RSK standards was identified. Data collected during the 2005 site characterization investigation indicates this area encompasses approximately 11.2 acres.

The depth of impact above the RSK standard across the area ranges from 3.5 to 11.5 feet below grade. However, since surface and subsurface soils are an environmental risk pathway, both soils are considered in this evaluation.

Concentrations of total nitrogen in surface soils (0-2 foot depth) were found to be as high as 1,989 mg/kg in the area of the former Concentrate Ponds. Concentrations in subsurface soils were found to be as high as 6,750 mg/kg. The highest concentrations were found in the area immediately west of the existing above-ground land application water storage tank #6 (formerly UAN storage tank). Samples that exceeded the RSK standard for ammonia plus nitrate cover an area of approximately 11.2 acres at an average depth of 6.2 feet. The calculated volume of impacted surface and subsurface soils is approximately 111,700 cubic yards, based on site characterization data (36,000 cubic yards of surface soils; 75,700 cubic yards of subsurface soil). These volumes account for soil removed previously to construct the #6 Tank secondary containment structure.

The Central Ponds located at the south edge of the former Concentrate Ponds area underwent interim remedial action in 2006 (discussed in detail in Section 6.1). Since samples collected from the Central Ponds during site characterization are no longer representative of the remaining soils, the results obtained from these ponds will not be included in the following discussion.

Remediation of both surface and subsurface soils containing nitrate or ammonia concentrations above the RSK standard is considered in order to mitigate impact to shallow groundwater in the overburden and bedrock and mitigate impact to surface water exiting the Site. The area inside the former UAN storage tank containment berm appears to be non-impacted based on one sample location, and the volume of surface soil has been adjusted to exclude the tank containment area. As such, remediation of 11.2 acres of surface and subsurface soils within the
Sandstone Hill and Concentrate Ponds area is evaluated. The volume of surface soil in this area is approximately 111,700 cubic yards.

Potential remediation options include:

- **Excavate and landfill on-site (Area B ponds)** – Removal of soils to the full depth and extent of impacts above RSK values and replacement with clean fill as needed to restore effective surface drainage. Removed soil would be transported to the Area B ponds for disposal, along with impacted soils from other areas of the Site. Site-wide LURs would be placed on the property.

- **Limited excavation of surface soils (0-2' depth)** – Remove surface soils with concentrations above 1,000 mg/kg nitrate plus ammonia. Transport and place excavated soil in Area B ponds. Backfill with clean fill from on-site source and seed surface. LURs would be required to prevent removal of top two feet of soil within the footprint of the excavation unless for building purposes, and to require proper management/disposal of soils excavated for building purposes.

- **Phytoremediation** – Impacted soils remain in place. Establishment of plants proven to extract high levels of nitrogen compounds from soils (e.g. hybrid poplar trees and switch grass) to bring about accelerated uptake and utilization of nitrogen compounds. LURs would be needed to protect planted vegetation from removal and attrition and to provide required upkeep to maintain healthy plant conditions.

- **Cap with topsoil** – Impacted soils remain in place. Clean topsoil placed to a minimum depth of 2 feet, compacted, graded, and seeded. LURs would be required to prevent removal of top two feet of soil within the footprint of the cap unless for building purposes, to require proper management/disposal of soils excavated for building purposes, and to repair incidental erosion damage within the footprint of the cap.

- **No additional action taken** – Utilize existing storm water collection and discharge practices to control environmental impacts. LURs would be required for proper management/disposal of soils excavated for building purposes.

**Evaluation of Alternatives**

The following surface soil remediation options were identified and evaluated for this area.
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation of soils with concentrations above RSK standard remediation goals. Transport and place excavated soils in Area B ponds. Backfill with clean fill from on-site source and seed surface.</td>
<td>$2,264,800 Based on 111,700 cubic yards of soil over approx. 11.2 acres to average depth of 6.2 feet.</td>
<td>o Area B ponds do not have sufficient available volume for this amount of soil. o Requires clean fill, earthwork, and erosion control upon completion. o Soil/sediment stability issues in receiving ponds.</td>
<td>o Fully eliminates source from overburden soils on Hill. o Can be completed in a relatively short time frame (i.e. months). o Allows for unrestricted land use upon completion.</td>
</tr>
<tr>
<td>Limited excavation of surface soils with concentrations above 1,000 mg/kg nitrate plus ammonia. Transport and place excavated soil in Area B ponds. Backfill with clean fill from on-site source and seed surface.</td>
<td>$281,550 Based on 13,500 cubic yards of soil over 4.2 acres.</td>
<td>o Requires fill, earthwork, erosion control, and seeding upon completion. o Soil/sediment stability issues in receiving ponds. o Does not address subsurface soil impacts.</td>
<td>o Eliminates majority of shallow source materials and improves storm water runoff quality from the Hill. o Can be completed in a relatively short time frame (i.e. months). o Allows for more flexible land use compared to other options.</td>
</tr>
<tr>
<td>Plant Poplar trees and Switchgrass (or other suitable plant species) to enhance phytoremediation of nitrogen concentrations in the soils. Estimate approximately 800 hybrid Poplar trees and Switchgrass. Includes 5 years of monitoring and maintenance.</td>
<td>$587,600 Based on application over approx. 11.2 acres.</td>
<td>o 5 to 10 year timeframe. o Will require irrigation to establish plant growth which could temporarily increase flow from seeps. o Loss of use of the treatment area for the duration of remediation. o Maintenance required by harvesting of grass to maximize nitrogen loss. o Harvesting of Switchgrass required.</td>
<td>o Eliminates &quot;Hot Spot&quot; source, including subsurface soils. o Potentially addresses deeper seeps. o Improves surface water runoff quality. o Provides good public relations and university research opportunities. o Requires no major earthwork. o Allows for eventual unrestricted land use.</td>
</tr>
</tbody>
</table>
### Remedial Action Plan

**Former Farmland Nitrogen Plant**  
**Lawrence, Kansas**

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap affected area (11.2 acres) with 2’ of clean fill soil from on-site source, and reseed.</td>
<td>$380,000</td>
<td>o Provides no improvement to subsurface soil or groundwater.</td>
<td>o Easily implemented.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Only addresses surface runoff impacts.</td>
<td>o Does not require disposal space in Area B ponds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Requires protection from erosion and long-term maintenance.</td>
<td>o Lower cost than 1st and 3rd option..</td>
</tr>
<tr>
<td>No additional action taken. Maintain current activities for collection of runoff water.</td>
<td>No additional cost.</td>
<td>o Provides no improvement to surface soil, subsurface soil, or groundwater.</td>
<td>o Low cost.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Probable lack of public and regulatory acceptance.</td>
<td>o NPDES discharge limits are being met without performing remedial action.</td>
</tr>
</tbody>
</table>

**Preferred Remedial Alternative**

The preferred remedial option for soil impacts in the former Concentrate Ponds and Sandstone Hill area is selective removal of the highest concentrations in surface soil (0 to 2 foot depth), specifically surface soils with nitrate plus ammonia concentrations greater than 1,000 mg/kg. This remedy is the least costly option, aside from taking no additional action, and was selected based on anticipated benefits to the Site, including:

- Improvement of storm water runoff from the Sandstone Hill, which currently is some of the highest concentration storm water on the Site.
- Sufficient capacity is available in Area B ponds for the limited quantity of soil, making on-site disposal possible, whereas full excavation of all impacted soils would make on-site disposal problematic.
- A limited excavation can be backfilled with on-site borrow materials, thus reducing costs of remediation.
- Soil removal can be easily implemented and does not require further engineering design or study.

Reduction of surface nitrogen concentrations by this method is expected to be immediate. Subsurface reductions in nitrogen will occur by long-term infiltration of water and migration of nitrogen compounds through groundwater seeps. **Figure 7-11** illustrates the areas of affected soil impacts and the area of the proposed limited surface soil removal. Appropriate LURs would be placed on this area of the Site.
7.3.2 Central Ponds Soils

During the interim measures performed in May and June 2006, sediments impacted by nitrogen compounds were removed from the area of the Central Ponds and placed in the East Lime Pond. The Central Ponds were then removed and the area backfilled and graded to allow drainage.

Since completion of the interim measures, the surface soils in the area of the former Central Ponds have received impact from nitrogen compounds primarily from impacted groundwater that daylights as seepage along the southern portion of the UAN Storage Area (Sandstone Hill) and to a lesser degree from storm water runoff impacted with nitrogen compounds also originating from the UAN Storage Area (Sandstone Hill). Impacts to the surface soils in this area are evidenced by crystallized residue from evaporated seep water on the ground surface. Sampling of the seeping groundwater indicated ammonia at 2,400 mg/L and nitrate at 4,500 mg/L.

An interceptor trench is planned for installation as part of the primary remedial priorities immediately upgradient of the former Central Ponds to capture the impacted groundwater seepage and contain for use in the land application program.

Following the installation of the interceptor trench, the surface soils in the area of the former Central Ponds will be excavated and transported to the Area B ponds for disposal. Approximately 2,500 cubic yards of soil are anticipated to be removed from this area of approximately 0.5 acres in size to a depth of three feet to assist in improving the storm water runoff quality from the area. Following excavation the area will be backfilled, graded, and seeded with vegetation.

Because of the small volume of soil estimated to be involved, only one remedial alternative was evaluated:

- Excavation and landfilling on-site (Area B ponds) – Removal of surface soils within the area of the former Central Ponds (approximately 0.5 acres) to a depth of three feet. Removed soil will be transported to the Area B ponds for disposal and the area will be backfilled using material from on-site sources and seeded with vegetation. The area will fall under the Site-wide LURs.

Preferred Remedial Alternative

As only one remedial alternative was evaluated, the preferred remedial option for nitrogen impacted surface soil in the area of the former Central Ponds is removal and placement in the Area B ponds. Surface soil will be excavated to a depth of three feet over the 0.5-acre area (approximately 2,500 cubic yards) and transported to the Area B ponds for disposal. The area will then be backfilled using material from on-site sources, graded, and seeded with vegetation. The estimated costs to complete this remedial alternative are $52,800.
7.3.3 Dam Pond Sediments

A surface water drainage rill present in the far northwest part of Area A has been the subject of environmental investigation since the 1970’s. Surface water and soil investigations were conducted in several phases to identify the source of high nitrate concentrations in surface water exiting the Site on the west side of the Bag Warehouse (Currens, 1982). Surface water in this area contained total nitrogen concentrations in the range of 380 to 800 mg/L. The investigation concluded that the contamination of the runoff was because of high nitrate and ammonia concentrations in soils west of the former concentrate ponds.

As a result of the findings of this investigation, a dam was constructed in the early 1990’s near the bottom of the drainage rill to retain impacted runoff water. Drainage of the accumulated water was directed by piping to the Krehbiel Pond at the west end of Area B. Figure 7-5 shows the location of the dam, pond, and diversion pipe. As a result of the pond and water diversion, surface water exiting the northwest corner of the Site is not impacted. At some time in the past, accumulated sediments from the pond may have been removed and placed outside the pond.

This section discusses remedial actions to be taken in the Dam Pond area directed at surface water and pond sediment remediation only. Shallow groundwater and subsurface soils are not media of concern for this area.

Surface soil samples were collected from the drainage rills and from the perimeter of the Bag Warehouse during the 2005 investigation. No unusually high concentrations of nitrate or ammonia were observed at that time. No data are available for sediments from the Dam Pond itself. However, it is assumed that the sediments in the pond have been impacted to some degree by nitrates and ammonia in storm water runoff from the Sandstone Hill. Sediments are believed to have been removed from the pond and placed outside the dam.

To confirm the condition of the sediments in the pond, samples were collected from eight (8) locations within the footprint of the pond from the 0-2 foot depth interval for laboratory analysis of nitrate and ammonia. Surface vegetation was firmly established outside the footprint of the pond and, therefore, no samples were collected outside of the pond. The following table presents a summary of the sample analyses.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Date Sampled</th>
<th>Ammonia-Nitrogen (mg/kg)</th>
<th>Nitrate/Nitrite-Nitrogen (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPSS-1</td>
<td>09/24/08</td>
<td>447</td>
<td>15</td>
</tr>
<tr>
<td>DPSS-2</td>
<td>09/24/08</td>
<td>335</td>
<td>55</td>
</tr>
<tr>
<td>DPSS-3</td>
<td>09/24/08</td>
<td>826</td>
<td>131</td>
</tr>
<tr>
<td>DPSS-4</td>
<td>09/24/08</td>
<td>593</td>
<td>283</td>
</tr>
<tr>
<td>DPSS-5</td>
<td>09/24/08</td>
<td>552</td>
<td>267</td>
</tr>
<tr>
<td>DPSS-6</td>
<td>09/24/08</td>
<td>725</td>
<td>265</td>
</tr>
<tr>
<td>DPSS-7</td>
<td>09/24/08</td>
<td>601</td>
<td>198</td>
</tr>
<tr>
<td>DPSS-8</td>
<td>09/24/08</td>
<td>434</td>
<td>&lt;6.0</td>
</tr>
</tbody>
</table>
Based on the laboratory analytical results, the sediments within the footprint (estimated to be approximately 90 feet by 50 feet) of the pond will be excavated to an approximate depth of 2 feet and transported to the Area B ponds for disposal. An estimated 350 cubic yards of sediment will be removed.

Because of the small volume of sediments estimated to be involved, only one remedial alternative was evaluated:

- Excavation and landfilling on-site (Area B ponds) – Removal of sediments from within the footprint of the pond. Removed sediments will be transported to the Area B ponds for disposal. LURs will be needed on the area of the Dam Pond to protect the pond from erosion, removal, or bypass.

The Dam Pond serves an important function in protecting the quality of surface water exiting the Site. Therefore, the pond will be left in place and maintained until surface water runoff from the Sandstone Hill can be allowed to discharge directly from the Site.

Preferred Remedial Alternative

As only one remedial alternative was evaluated, the preferred remedial option for nitrogen-impacted sediments in the Dam Pond is removal and placement in the Area B ponds. Sediments will be excavated to a depth of 2 feet from within the footprint of the pond. LURs will be needed to prevent removal of the pond and prevent surface water drainage from the hill to bypass the pond. The estimated costs to complete this remedial alternative are $6,000.

It is not anticipated that additional sediment removal actions in the future will be required within the Dam Pond area. As Site conditions are expected to improve over time, future sediments accumulated within the Dam Pond are not anticipated to have significant concentrations of nitrate and ammonia.

7.3.4 Krehbiel and West Ponds

As a result of the implementation of the RAP strategies to minimize storm water contacting impacted surface soils, the quality of storm water currently routed through the West Pond and Krehbiel Pond will improve. When it is no longer necessary to contain this water for use in the land application program, the storm water can be directed to the main effluent ditch. Monitoring of the storm water currently routed through these two ponds will be performed to determine when quality of the storm water is acceptable for direct discharge.

Once the quality of storm water runoff is acceptable for direct discharge, the sump and piping installed in the West Pond will be removed and the existing dike between the West Pond and Krehbiel Pond will be removed. The sump and pump located in Krehbiel Pond will also be removed. In order to direct the water flowing through these two ponds to the main effluent ditch, the existing overflow structure located at the west end of Krehbiel Pond will be used.
The base of both ponds will be graded to direct storm water flow to the overflow structure at the west end of Krehbiel Pond. Material from the removed dike between the two ponds will be used to facilitate grading. As impacted sediments were previously removed from these two ponds (Interim Measures, Section 6.10 and 6.11) it is not anticipated that additional sediment removal will be performed.

The scope of work associated with directing storm water flow through West Pond and Krehbiel Pond to direct discharge to the main effluent ditch can be performed for an approximate total cost of $30,000.

7.3.5 Area B Ponds

Area B is comprised of a series of ponds located in the far northern area of the Site. These ponds, in order from west to east, are Krehbiel Pond, West Pond, West Extension Pond, West Effluent Pond, East Effluent Pond, West Lime Pond, Rundown Pond, Overflow Pond, and East Lime Pond. This total area covers approximately 66 acres. These ponds were designed to receive different process waters and storm water runoff from the Site.

Interim remedial measures have been performed in Krehbiel Pond, West Pond, and the Overflow Pond as previously discussed in Section 6. This section addresses remedial measures for the West Extension Pond and the remaining 5 primary ponds (excluding the Overflow Pond previously addressed in the interim measures).

Based on site characterization activities described in Section 3 of this document, nitrate and ammonia were detected in sediments accumulated in these ponds with concentrations of ammonia as high as 23,700 mg/kg and nitrate concentrations as high as 10,900 mg/kg. Of the metals analyzed, only arsenic was detected above non-residential RSK values at one location in the Area B pond sediments.

These sediments and, potentially, the upper portion of the native clay pond bases immediately underlying the sediments were identified as a primary source area of nitrogen compounds. Addressing these impacted materials would be required before closure of the ponds could be accomplished and to assist in the long-term mitigation of impacts to groundwater from the nitrogen compounds leaching from the material. The following table summarizes the volume of sediments estimated to be in each of the seven ponds.
<table>
<thead>
<tr>
<th>Pond Name</th>
<th>Estimated Volume of Sediment</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Extension Pond</td>
<td>12,800 cubic yards</td>
</tr>
<tr>
<td>West Effluent Pond</td>
<td>43,000 cubic yards</td>
</tr>
<tr>
<td>East Effluent Pond</td>
<td>31,300 cubic yards</td>
</tr>
<tr>
<td>West Lime Pond</td>
<td>61,000 cubic yards</td>
</tr>
<tr>
<td>Rundown Pond</td>
<td>50,000 cubic yards</td>
</tr>
<tr>
<td>Overflow Pond</td>
<td>15,154 cubic yards</td>
</tr>
<tr>
<td>East Lime Pond</td>
<td>31,000 cubic yards</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>244,254 cubic yards</strong></td>
</tr>
</tbody>
</table>

A preliminary conceptual design for the decommissioning of these ponds was submitted to KDHE in October 2006. The conceptual plan outlined a scenario where impacted sediment would be excavated from the West Extension, West Effluent, East Effluent, and Overflow Ponds. The excavated sediments would be placed in the West Lime, Rundown, and East Lime Ponds, re-graded, and capped. In addition, the primary site drainage way would be modified to flow between the West Effluent Pond and the West Extension Pond. The conceptual design was conditionally approved for implementation in November 2006. However, it was requested that before implementation, additional details be provided for this scenario including the confirmation of quantities to be excavated, the development of a final grading plan for all the ponds, the material that would be used to cap the ponds where the impacted sediment would be placed, the design of the primary site storm water drainage way, needed erosion controls, and the need for a storm water detention structure.

In March 2007 a draft Area B, Northern Ponds Decommissioning Plan was submitted to KDHE providing the requested information. In May 2007 KDHE approved the proposed activities associated with the Overflow Pond. However, it was determined that the remaining pond closure activities should be addressed in the overall remedial plan for the Site. In August and September 2007 the sediments from the Overflow Pond were excavated and placed into the Rundown Pond. Further details on these activities are provided in Section 6.9.

During the past three years through collaborative effort with KDHE and the Trust, the following remedial alternatives were evaluated:

- **Land Application of Sediments** – Involves removing the sediments from the West Extension Pond, West Effluent Pond, East Effluent Pond, West Lime Pond, Rundown Pond, Overflow Pond, and East Lime Pond by creating a slurry and transporting the slurried material to agricultural ground for application as fertilizer. Approximately 244,250 cubic yards of material is estimated to be in these 7 ponds.

- **Cap all Sediments in Place and Cover** – Existing sediments in the six ponds (excludes the Overflow Pond) would be left in place, graded for drainage, covered with a bentonite mat and a minimum of 18-inches of soil cover. Additional cover material will be required.
in most locations to achieve a grade necessary for the drainage of storm water. This option has not been evaluated with respect to construction of the new storm water drainage ditch. It is anticipated the drainage requirements for this option would be similar to those for the consolidation option. However, it will be necessary to re-run the hydrologic models to confirm detention capacity and finalize design requirements. The specific drainage ditch options discussed in Section 7.2.2 may not apply with this option.

- **Removal of Sediments, Consolidation, Cap and Cover** – Removal of the existing sediments in the West Extension Pond, West Effluent Pond, and East Effluent Pond as well as impacted soil from other areas of the Site. Sediments and soil would be consolidated in the West Lime Pond, Rundown Pond, and East Lime Pond. The 3 consolidation ponds and the West Extension Pond would then be capped and covered with a bentonite mat and minimum of 18-inches of soil cover.

- **Removal of Sediments, Consolidation, and Cap** – Removal of the existing sediments in the West Extension Pond, West Effluent Pond, and East Effluent Pond as well as impacted soil from other areas of the Site. Sediments and soil would be consolidated in the West Lime Pond, Rundown Pond, and East Lime Pond. The 3 consolidation ponds and the West Extension Pond would then be covered with a minimum of 18-inches of soil cover and seeded with deep-rooted vegetation.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Removal of the sediments from the ponds down to contact with native clay base and land application of the sediments on farm ground as fertilizer. | $10,000,000 |  - This option was not pursued further as it is logistically not feasible to locate sufficient acreage of farm ground within a reasonable distance of the site. Initial estimates are that 23,000 acres of farm ground would be required.  
  - Off-site contamination.
  - Transportation and land application impractical. |  - Removes the source from the site.
  - Possible beneficial use as fertilizer. |
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Cap all sediments in place and cover with a bentonite mat and soil cover. | $2,900,000 plus 10 year cap maintenance at $635,000 Total $3,535,000 | o Does not decrease the footprint of impacted sediments left in place.  
 o Leaves impacted sediments in place beneath the detention basin for the new storm water drainage ditch.  
 o Requires a significant volume of fill material to achieve a grade suitable for drainage of storm water. Sufficient fill may not be available on-site.  
 o Requires additional cap maintenance for settlement of the underlying impacted sediments.  
 o Sediments could still come into contact with groundwater.  
 o Will require re-running of the hydrologic models to determine design requirements for this option with respect to construction of the new storm water drainage ditch. | o Reduces infiltration.  
 o Provides the capacity to excavate impacted soils from other areas of the site for placement in the ponds before capping and cover.  
 o Eliminates the potential for additional excavation into the clay layer below the East and West Effluent ponds should the contamination continue below the sediment layer. |
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of sediments from the West Extension Pond, and impacted soils from</td>
<td>$1,375,000 plus 30 year cap maintenance at $826,000</td>
<td>o Sediments in the West Lime, Rundown, and East Lime Ponds may require stabilization in order to support the weight of the sediments removed from the other ponds, the cap, and the cover. Slab-on-grade construction in this area will likely not be possible.</td>
<td></td>
</tr>
<tr>
<td>other areas of the Site, consolidating the sediments into the West Lime,</td>
<td>Total $2,201,000</td>
<td>o Removed sediments may require stabilization before placement.</td>
<td>o Reduces the footprint of impacted sediments.</td>
</tr>
<tr>
<td>Rundown, and East Lime Ponds, capping with a bentonite mat, and covering with</td>
<td>Based on 43,800 cubic yards of material which includes 12,800 cubic yards of sediment and the upper 6-inches of the native clay base and 31,000 cubic yards of soil from other areas of the Site. Excludes the Overflow Pond and the East and West Effluent Ponds as the sediments have already been removed from these ponds.</td>
<td>o Significant earthwork.</td>
<td>o Removes sediments from the area of the detention basin for the new storm water drainage ditch.</td>
</tr>
<tr>
<td>18-inches of soil.</td>
<td></td>
<td>o An LUR will be necessary requiring the cap to be maintained in perpetuity. For the estimating purposes cap maintenance is based on 30 years from the date of final closure of the ponds.</td>
<td>o May provide some additional capacity for removal of additional pond base material if necessary.</td>
</tr>
</tbody>
</table>
Remedial Action Plan  May 22, 2009
Former Farmland Nitrogen Plant
Lawrence, Kansas

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of sediments from the West Extension Pond, and impacted soils from other areas of the Site, consolidating the sediments into the West Lime, Rundown, and East Lime Ponds, and 18-inches of soil cover seeded with deep-rooted vegetation.</td>
<td>$1,086,500 plus 30 year cover maintenance at $826,000 Total $1,912,500 Based on 43,800 cubic yards of material which includes 12,800 cubic yards sediment and the upper 6-inches of the native clay base and 31,000 cubic yards of soil from other areas of the Site. Excludes the Overflow Pond and the East and West Effluent Ponds as the sediments have already been removed from these ponds.</td>
<td>o Sediments in the West Lime, Rundown, and East Lime Ponds may require stabilization in order to support the weight of the sediments removed from the other ponds, and the cover. Slab-on-grade construction in this area will likely not be possible. o Removed sediments may require stabilization before placement. o Significant earthwork. o An LUR will be necessary requiring the cover to be maintained in perpetuity. For the estimating purposes cover maintenance is based on 30 years from the date of final closure of the ponds. o The current conceptual design of the cover will require re-evaluation once the ponds are ready for final closure to account for the actual volume of sediment and soil placed in the ponds.</td>
<td>o Reduces the footprint of impacted sediments. o Removes sediments from the area of the detention basin for the new storm water drainage ditch. o May provide some additional capacity for removal of additional pond base material if necessary. o Soil cover with deep-rooted vegetation will provide potential reduction in nitrogen compounds as the vegetation becomes established and begins to uptake nitrogen.</td>
</tr>
</tbody>
</table>

The above alternatives include sediment removal from the East and West Effluent Ponds. However, the removal of sediments from these two ponds was previously addressed in Section 7.2.2. Therefore, the costs presented in the evaluation table reflect only that portion of the scope of work that remains to complete the closure of the Area B Northern Ponds. These activities included sediment removal from the West Extension Pond and capping/covering of the West Extension, West Lime, Rundown, and East Lime Ponds.

The following discussion provides details on the pond closure activities that will be performed for each pond. In general, excavation of the sediments will be performed to the engineered depth of each pond as marked by the contact with the native clay base of each pond using suitable earth-moving equipment. The upper six-inches of the native clay base will be removed with the sediments. The excavated sediments will be placed in trucks and transported to the West Lime,
Rundown, or East Lime Pond (consolidation ponds). As the sediments are placed in these ponds, they will be spread and compacted to the extent possible. Based on the sediment removal performed on the Overflow Pond in 2007, it does not appear that it will be required to mix Portland cement with the excavated sediments to improve spreading and compaction.

Once the sediments and 6-inches of native clay base have been removed from a pond, sampling will be performed on the remaining pond base material to evaluate if removal of additional pond base material is warranted or feasible.

Once the sediments have been removed from the ponds, the area will be restored. Area restoration will include backfilling, grading, and seeding with deep-rooted native vegetation in the ponds from which the sediment was removed. The consolidation ponds will be covered with a minimum of 18-inches of soil cover, graded to allow storm water runoff from the area to be directed to the north. Runoff will then follow existing drainage patterns. The area of the consolidation ponds will then be seeded with deep-rooted native vegetation.

Backfill material will be obtained from borrow areas on-site. It is estimated that approximately 300,000 cubic yards of on-site fill material is available from various areas around the site. These areas are indicated on Figure 7-12. It is anticipated that LURs will be placed on these areas to stipulate that if they are removed/used as part of property development, the developer will be responsible for providing suitable borrow material in the required volume to complete the pond closure activities.

Based on the selected options for the pond closure activities, it is estimated that approximately 125,000 cubic yards of fill material will be required. Based on the estimated required volume, a sufficient volume of on-site fill is available. Should off-site backfill material be required, representative samples of the material from the proposed borrow site will be collected for laboratory analysis. The samples will be analyzed for the same contaminants of concern as the samples obtained from the native clay base in each pond. In addition, these samples will be analyzed for volatile and semi-volatile organic compounds.

Before implementing the pond closure activities, it will be necessary to remove standing water in the West Lime, Rundown, and East Lime Ponds. Samples of the water will be obtained and analyzed for nitrogen compounds to assist in the management of this water.

During dewatering activities, storm water runoff from non-impacted areas of the Site as well as runoff coming from areas south of the Site will continue to be directed through the new storm water drainage ditch. Storm water runoff from impacted areas of the site will continue to be directed to the Overflow Pond.

A Notice of Intent (NOI) and a construction storm water permit application was submitted in April 2007 addressing the closure of the northern ponds. The revised NOI was submitted on July 27, 2007 to include Phase 1 of the pond closure activities, which included the actions performed on the Overflow Pond discussed in Section 6.9. The amended NOI will be further amended to include the activities in Phase 2 of the pond closure activities, which includes the removal of sediments from the West Extension, West Effluent, and East Effluent Ponds with consolidation of these materials in the West Lime, Rundown, and East Lime Ponds and the capping and covering of these ponds. The amended NOI will address the proposed borrow areas and present the proposed final surface contours for those areas.
An Erosion Control Plan will be prepared for the Site outlining the best management practices that will be followed to control erosion from normal storm water runoff, pond dewatering activities, and pond decommissioning construction activities. The Erosion Control Plan will identify the type of erosion control to be used, placement of erosion control devices, and necessary monitoring of erosion controls to minimize erosion during the activities.

The following sections provide details on the pond closure activities that will be performed for each pond.

### 7.3.5.1 West Extension Pond

Accumulated sediment in the West Extension Pond was found to be in excess of 20 feet in thickness. As a result of this significant accumulation of sediment, specialized excavating equipment, such as a backhoe with an extended reach boom, and excavation methods will be required to safely remove the sediment from this relatively small area.

It is anticipated that excavation of the sediment in this pond will begin in the north and proceed to the south. The sediment will be excavated down to a depth of 20 feet below existing grade. Upon reaching this target depth an evaluation will be made to determine if additional sediments should be removed and, if so, whether the additional sediments can be excavated safely.

Benching of the excavation will be performed as necessary to allow the sediments to be removed to the necessary depth. Partial backfilling of the excavation will be required in the northern portion of the pond as the excavation proceeds to the south.

An estimated 12,800 cubic yards of material will be removed from the West Extension Pond and placed in the consolidation ponds.

Once the material has been removed from the West Extension Pond, samples of the material remaining in the base of the pond will be collected for analysis of nitrogen compounds (nitrate and ammonia). Samples will be obtained from one location within the footprint of the pond to a depth of 9-feet below grade or until groundwater is encountered, whichever comes first. The samples will be collected in one foot intervals. Because of the depth of excavation in the West Extension Pond, the samples will be collected using excavation equipment.

Once it has been determined that additional excavation is not required or not safely feasible, the West Extension Pond will be backfilled with clean rubble and borrow material, including the existing northern dike, and graded to allow storm water drainage to the north into the effluent ditch. Existing electrical service lines to the North Sump and the Effluent Pond discharge structure located along the northern dike will be re-located. The dike along the eastern side of the West Extension Pond will be maintained in support of the construction of the new storm water drainage ditch.

A minimum of 18-inches of soil cover will be placed over the borrow material. The soil cover will be graded and contoured to eliminate low-lying areas and maintain a northerly drainage of storm water. An estimated 3,000 cubic yards of fill material from on-site sources will be used for the 18-inch soil cover. The entire area of the former West Extension Pond will be seeded with deep-rooted native vegetation.
7.3.5.2 West Effluent Pond
An estimated 43,000 cubic yards of material (including 6-inches of native clay base) will be removed from the West Effluent Pond and placed in the consolidation ponds as discussed in Section 7.2.2.

7.3.5.3 East Effluent Pond
An estimated 31,300 cubic yards of material (including 6-inches of native clay base) will be removed from the East Effluent Pond and placed in the consolidation ponds as discussed in Section 7.2.2.

7.3.5.4 West Lime Pond and Rundown Pond
The West Lime Pond and the Rundown Pond are two of three ponds that will be used for the consolidation of the excavated material. These two ponds are adjacent to one another (separated by the current by-pass drainage ditch) and they will be treated as one consolidation unit for the purpose of this discussion.

The West Lime Pond and the Rundown Pond (including the by-pass drainage ditch) have a capacity for 91,100 cubic yards of excavated material. 15,200 cubic yards of material from the Overflow Pond have already been placed in the Rundown Pond leaving an available capacity of 75,900 cubic yards. The estimated 43,000 cubic yards of material from the West Effluent Pond and the estimated 31,300 cubic yards of material from the East Effluent Pond will be consolidated into the West Lime Pond and Rundown Pond with almost all of this volume being placed in the Rundown Pond. The West Lime Pond will only receive material as required to meet the proposed final grade. This provides an additional capacity of approximately 1,600 cubic yards of material from other areas of the Site.

The existing sediments in the West Lime Pond and Rundown Pond will not be stabilized before accepting excavated materials, and the excavated materials will be placed starting in the south end of the ponds. The excavated material will be bridged out over the existing sediments to create a surface to support the necessary equipment to spread the materials and placement will continue to the north. Based on the sediment removal from the Overflow Pond performed in 2007, it does not appear necessary to mix Portland cement with the excavated sediments to improve spreading and compaction.

The excavated material will be graded and contoured to meet the proposed final grading plan as illustrated on Figure 7-13. Once it has been determined that no additional impacted materials will be placed in the West Lime and Rundown Ponds, 18 inches of soil cover placed over the sediments. The soil cover will be graded and contoured to maintain the drainage of storm water pursuant to the proposed final grading plan. An estimated 35,600 cubic yards of fill material from on-site sources will be used for the 18-inch soil cover. The entire area will then be seeded with deep-rooted native vegetation.

The deep-rooted vegetation could include poplar trees and alfalfa, silage/forage sorghum, or similar vegetation. The ultimate vegetation selected could be based on the end use of the area through the Site redevelopment. For example, if the area is planned for use as green space for the development, trees and similar vegetation may be preferred. Following the initial planting of the vegetation, future planting/harvesting of the vegetation, if appropriate, is considered to be an
activity that will not be an expense. It is assumed an agreement would be reached with an area
farmer to allow the planting and harvesting of the vegetation at no cost to the Trust as the farmer
would benefit from the harvest.

The current proposed final grading plan is based on the West Lime Pond and Rundown Pond
accepting up to 91,100 cubic yards of excavated material. It may be possible to place additional
material above this volume in these ponds but the proposed final grading plan would need to be
re-evaluated. Costs have been provided in the final pond closure estimate to design the cover to
achieve the desired drainage based on the volume of material actually placed in these ponds.

As the existing sediments in the West Lime and Rundown Ponds will not be stabilized before
placing excavated materials in these ponds, settling of the material will occur over time.
Therefore, it will be necessary to perform maintenance on the covered surface of these ponds on
a yearly basis. Maintenance activities will include a yearly survey of the covered surface to
determine the amount of settlement that has occurred. Clean fill material from on-site will then be
brought in and placed to restore the final grade, eliminate low-lying areas, and maintain storm
water drainage pursuant to the final grading plan. As necessary, re-seeding of native vegetation
will also be performed.

7.3.5.5 East Lime Pond

The East Lime Pond is the third pond that will be used for the consolidation of the excavated
material.

The East Lime Pond has a capacity for 33,600 cubic yards of excavated material. The estimated
12,800 cubic yards of material from the West Extension Pond will be consolidated into the East
Lime Pond. This provides an additional capacity of approximately 20,800 cubic yards of material
from other areas of the Site.

The existing sediments in the East Lime Pond will not be stabilized before accepting excavated
materials and the excavated materials will be placed starting in the south end of the pond. The
excavated material will be bridged out over the existing sediments to create a surface to support
the necessary equipment to spread the materials and placement will continue to the north. Based
on the sediment removal from the Overflow Pond performed in 2007, it does not appear
necessary to mix Portland cement with the excavated sediments to improve spreading and
compaction.

The excavated material will be graded and contoured to meet the proposed final grading plan as
illustrated on Figure 7-13. Once it has been determined that no additional impacted materials
will be placed in the East Lime Pond, 18 inches of soil cover will be placed over the sediments.
The soil cover will be graded and contoured to maintain the drainage of storm water pursuant to
the proposed final grading plan. An estimated 8,300 cubic yards of fill material from on-site
sources will be used for the 18-inch soil cover. The entire area will then be seeded with deep-
rooted native vegetation. This vegetation would be similar to that previously described for the
West Lime and Rundown Ponds.

The current proposed final grading plan is based on the East Lime Pond accepting up to
33,600 cubic yards of excavated material. It may be possible to place additional material above
this volume in this pond but the proposed final grading plan would need to be re-evaluated.
Costs have been provided in the final pond closure estimate to design the cover to achieve the desired drainage based on the volume of material actually placed in the pond.

As the existing sediments in the East Lime Pond will not be stabilized before placing excavated materials in the pond, settling of the material will occur over time. Therefore, it will be necessary to perform maintenance on the capped surface of the pond on a yearly basis. Maintenance activities will include a yearly survey of the capped surface to determine the amount of settlement that has occurred. Clean fill material from on-site will then be brought in and placed to restore the final grade, eliminate low-lying areas, and maintain storm water drainage pursuant to the final grading plan. As necessary, re-seeding of native vegetation will also be performed.

Preferred Remedial Alternative

Based on the evaluation of the identified options, the accumulated sediments in the West Extension Pond as well as impacted soils from other areas of the Site will be addressed through removal, consolidation, and covering in the West Lime, Rundown, and East Lime Ponds using an 18-inch soil cover, seeded with deep-rooted vegetation. Additional costs associated with the closure of the ponds include the disposition of the sediment before capping.

7.3.5.6 Sediment Stabilization

During the sediment removal activities performed in the Overflow Pond as discussed in Section 6.9, samples of the lime sludge and sediments in the West Lime, Rundown, and East Lime Ponds were collected for one-dimensional consolidation testing in accordance with ASTM D-2435. This testing was performed to determine the estimated rate and amount of settlement that could occur when the material was loaded with the sediments removed from the West Extension, West Effluent, and East Effluent Ponds.

The results of the testing indicate the existing lime sludge would undergo substantial consolidation and settlement upon loading with the sediments, cap, and cover. The results of the one-dimensional consolidation testing are provided in Appendix E.

To reduce the potential for consolidation and settlement, three options were evaluated:

- **Pre-consolidation** – involves consolidating the materials before placing the sediments through removing the standing water in the ponds, covering the ponds with a coarse geofabric and 1-2 feet of sand, and then 4-5 feet of fill. Drain lines are installed in the sand to extract water as it is “squeezed” out of the material. When water is no longer being removed, consolidation is considered complete.

- **Solidification** – involves the mixing of a pozzolanic reagent into the lime sludge material to improve its physical properties. The existing water in the ponds would be removed; cement or suitable alternative reagent would be pneumatically conveyed on the surface and mixed in with an excavator.

- **No stabilization** – no initial stabilization of the existing material would be performed. Yearly maintenance would be performed to restore the grade as a result of natural settlement. Assumes a total settlement of approximately 11 inches over 2 years with 80% of the settlement occurring during the first year.
and 20% occurring the next year. After the second year, only normal minor yearly cap maintenance would be required.

<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Estimated Timeframe</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| Pre-consolidation | $3,760,000      | 14 months before sediments could be placed on the material | ○ Extends the pond closure schedule by 14 months.  
○ Ponds will likely be unable to support future loading or development.  
○ Extensive additional earthwork for placement and subsequent removal of 5’ to 7’ of soil material for consolidation.  
○ Some future settlement could occur.  
○ Higher cost than the solidification option. | ○ Allows the Ponds to be capped without significant consolidation and settling.  
○ Minimizes future cap maintenance. |
| Solidification  | $3,260,000      | 7 months before sediments could be placed on the material | ○ Could decrease the capacity for storage of impacted sediments through the addition of the pozzolanic reagent.  
○ Some future settlement could still occur. | ○ Reduces the time required before capping activities can begin.  
○ Provides the potential for development with slab-on-grade construction.  
○ Minimizes future cap maintenance.  
○ Lower estimated cost than solidification option. |
<table>
<thead>
<tr>
<th>Method</th>
<th>Estimated Costs</th>
<th>Estimated Timeframe</th>
<th>Disadvantages</th>
<th>Advantages</th>
</tr>
</thead>
</table>
| No Stabilization       | $826,000 Total cost for cap maintenance for first two years ($297,600) to account for major settlement, minor maintenance for the following 8 years ($230,400), and general maintenance for the following 20 years ($298,000). This provides maintenance from the estimated date of cap installation for 30-years. Maintenance activities include mowing the area twice per year. | No delay in sediment placement | o During the period of settlement, ponding of water may occur on the surface of the capped areas.  
   o Issues may arise during sediment placement as the existing material may not support equipment.  
   o Slab-on-grade development will likely not be possible in this area.  
   o Depending on the amount of settlement that actually occurs, sufficient on-site fill material may not be available for the increased cap maintenance that will be required. An initial estimate of anticipated settling indicates sufficient on-site fill material should be available. | o Eliminates the delay in sediment placement.  
   o Lower cost than other options. |

**Preferred Remedial Alternative**

Based on the evaluation of the identified options, the preferred option for sediment disposition before capping is to not stabilize the sediment in the West Lime, Rundown, and East Lime Ponds, which will result in maintenance of the cap/cover over a thirty year period. Major maintenance events will be performed the first two years to restore the grade as a result of the natural settlement of these materials. Minor maintenance will be performed for the following eight years, and general maintenance will be performed for the remaining 20 years. This provides for cap maintenance from the final closure of the ponds for a period of 30 years. Cap maintenance activities will be scheduled in the late fall of each year to provide adequate time for vegetation to become established.

Sufficient on-site borrow material should be available for the cap maintenance activities. However, in the event sufficient on-site borrow material is not available for long-term minor and general maintenance activities, the farm ground to the north of the railroad tracks, which is owned
by the Trust, could be retained as a source of borrow material. The volume of borrow material for the long term minor and general maintenance activities is anticipated to be minor but will require coordination with the farming of these fields.

LURs would be required to limit the type of construction on top of the ponds without the performance of a geotechnical analysis and, as necessary, material augmentation by the developer. If the geotechnical analysis indicates sufficient support for building structures, then slab-on-grade construction will be allowed. No subsurface excavation will be allowed.

7.3.5.7 Overflow Pond

Accumulated sediments in the Overflow Pond were previously removed in August and September 2007. 15,154 cubic yards of sediment were removed from the Overflow Pond and placed in the Rundown Pond as discussed in Section 6.9.

The Overflow Pond will be used to contain impacted storm water runoff for future use in the land application program and overall NPDES compliance.

Once it has been determined that the Overflow Pond is no longer needed to contain impacted storm water runoff for land application, the pond can be closed. A conceptual closure plan for the Overflow Pond would include the removal of the northern dike and grading the base of the pond to drain to the north. Approximately 65,000 cubic yards of fill material will be required in this scenario to achieve the minimum grade for drainage necessary to facilitate vegetative growth. Figure 7-14 illustrates the conceptual grading plan.

As the land application program is assumed to be required for a period of 30 years, it is assumed the need for the Overflow Pond will extend well into the 30-year project life. Once the pond can be closed, the required fill from on-site sources will be placed and graded according to the conceptual closure plan. Following the placement and grading of the required fill material, the pond area will be seeded with deep-rooted native vegetation as previously described for the West Lime, Rundown, and East Lime Ponds.

Estimated costs for the closure of the Overflow Pond in accordance with the conceptual closure plan using on-site borrow material is $1,000,000. The conceptual closure plan is only one of several options that could be used to close the Overflow Pond depending on available funding and property development requirements. Other more effective options, including leaving the Overflow Pond in place for use as a green space pond, may be selected at the time the pond is no longer needed for the storage of impacted water. Options other than the conceptual closure plan presented in this document or leaving the Overflow Pond in place must be addressed through the RD/RA.

7.3.6 Area A Soils

As discussed in Section 7.1.3.8 soils impacted with nitrogen compounds are present in the Northeast Production Area. No action with LURs was the preferred remedial option for these soils.

However, as this area has good redevelopment potential, an allowance has been made for the management of impacted soils that may be encountered during the installation of subsurface
utilities in this area. An estimated 5,000 cubic yards of impacted soil have been included in the allowance, which includes excavation of the impacted soil with transportation to the northern ponds for disposal. Backfill is not included as it is assumed backfilling will already be included with the development activity.

The estimated cost associated with the excavation and transportation of 5,000 cubic yards of impacted soil to the northern ponds is $46,750.

### 7.3.7 Area D Soils

As discussed in Section 7.1.3.7 soils impacted with nitrogen compounds are present in the vicinity of Original Landfill and the #2 Urea Plant. No action with LURs was the preferred remedial option for these soils.

However, as this area has good redevelopment potential, an allowance has been made for the management of impacted soils that may be encountered during the installation of subsurface utilities in this area. An estimated 10,000 cubic yards of impacted soil have been included in the allowance, which includes excavation of the impacted soil with transportation to the northern ponds for disposal. Backfill is not included as it is assumed backfilling will already be included with the development activity.

The estimated cost associated with the excavation and transportation of 10,000 cubic yards of impacted soil to the northern ponds is $93,500.

### 7.3.8 Production Well Plugging

During the operational period of the Site, seven (7) production water wells, located east of the Site, were used to provide process water to the Site. These seven wells are currently not in use.

It is anticipated that these wells will be sold with the Site or will be sold to another third party. However, in the event these wells are not sold, they will need to be properly plugged and abandoned. The estimated cost associated with the proper plugging and abandonment of these seven wells is $36,400.
8.0 Remedial Alternatives and Cost Summary

On May 1, 2004 an initial deposit of $6,985,255 was made into the Remediation Trust for the Site and on May 1, 2006 an initial deposit of $7,830,000 was made into the Administrative Trust for the Site. As of April 30, 2009 the Remediation Trust has a balance of approximately $4.31 million and the Administrative Trust has a balance of approximately $6.17 million.

The remaining balances in the Remediation and Administrative Trust represent the initial deposit less expenses plus gains and/or losses from investments by the Trust. A summary of expenses associated with the Remediation Trust from 2004 through 2007 is provided in Section 8.2.

The following sections present a summary of the preferred remedial alternatives for each medium in each of the areas discussed in Section 7, a summary of historical costs from 2004 through 2007, a summary of future estimated costs, and an implementation strategy.

8.1 SUMMARY OF PREFERRED ALTERNATIVES

This section summarizes the preferred alternatives for each area presented in Section 7. The following table includes a brief description of each preferred alternative and proposed LURs. It should be noted that a site-wide LUR prohibiting the installation of groundwater wells and limiting residential zoning at the Site will be proposed for all areas. Figure 8-1 illustrates the proposed LURs for the applicable areas on Site.
TABLE 8-1
LURs and Preferred Remedial Alternatives

<table>
<thead>
<tr>
<th>Preferred Alternative</th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRIMARY REMEDIAL PRIORITIES – Groundwater Containment, Disposal, and Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater Monitoring Network Modifications</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Continuation of established monitoring program with addition of new monitoring wells in selected areas in northwestern part of site.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Groundwater Containment System Enhancements</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Enhanced groundwater interception and off-site migration control via the existing groundwater containment system, with the addition of: • One new pumping well. • Shallow interceptor trench at former Central Pond. • Collection sump at Dam Pond. Beneficial use of nitrogen through land application.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Land Application Program</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Continuation of existing land application program for disposal of nitrate-contaminated groundwater from enhanced groundwater containment system. Potential addition of new distribution pipe and irrigation equipment to allow expansion of the program to additional farm ground or modification of application agreements to meet water disposal needs.</td>
<td>Continuation of existing land application program for disposal of captured nitrate-contaminated storm water run-off. Potential addition of new distribution pipe and irrigation equipment to allow expansion of the program to additional farm ground or modification of application agreements to meet water disposal needs.</td>
</tr>
<tr>
<td></td>
<td>Surface Soil</td>
<td>Subsurface Soil</td>
<td>Groundwater</td>
<td>Surface Water</td>
</tr>
<tr>
<td>-----------------------</td>
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<td>---------------</td>
</tr>
<tr>
<td>PRIMARY REMEDIAL PRIORITIES – Land Use Restrictions: Contaminated Soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part of Area F</td>
<td>Site-wide restriction on residential use of property.</td>
<td>Site-wide restriction on residential use of property.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Area D – Paint Shop</td>
<td>Site-wide restriction on residential use of property.</td>
<td>Site-wide restriction on residential use of property.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Area D – Boiler</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Area D – Ammonia</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Area D – Nitric Acid</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>
### Preferred Alternative

<table>
<thead>
<tr>
<th>Area D – Cooling Towers</th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area D – Urea #2 Area</th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair and maintain existing pavement cover and continue current surface water runoff management activities. LURs to be put in place: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) require proper management/disposal of soils excavated for building purposes; c) require repair of incidental damage or weathering of pavement. Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>LURs to be put in place: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) require proper management/disposal of soils excavated for building purposes; c) require repair of incidental damage or weathering of pavement. Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
</tbody>
</table>
## Preferred Alternative

<table>
<thead>
<tr>
<th>Area A – Northeast Production and Bag Warehouse Areas</th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair and maintain existing pavement, and continue current surface water runoff management activities. LURs to be put in place: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) require proper management/disposal of soils excavated for building purposes; c) require repair of incidental damage or weathering of pavement. Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>LURs to be put in place: a) prevent removal or disturbance of any existing pavement or impermeable surface unless building construction or new pavement is put in its place; b) require proper management/disposal of soils excavated for building purposes; c) require repair of incidental damage or weathering of pavement. Site-wide restriction on residential use of property. Control of exposures by on-site industrial and construction workers to nitrate- and ammonia-contaminated soil will be accomplished through a site-wide Soil Management Plan.</td>
<td>See “Land Use Restrictions: Contaminated Groundwater &amp; Surface Water” for Area A – Northeast Production Area.</td>
<td>See “Land Use Restrictions: Contaminated Groundwater” for Area A – Northeast Production Area.</td>
<td></td>
</tr>
</tbody>
</table>
### Preferred Alternative

<table>
<thead>
<tr>
<th>Area</th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRIMARY REMEDIAL PRIORITIES – Land Use Restrictions: Contaminated Groundwater &amp; Surface Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area A – Northeast Production Area</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Continued operation, maintenance, and monitoring of the existing interceptor trenches, French drain, and pumping wells, with disposal of water through land application. Site-wide LURs would be required to prohibit the installation of drinking water wells for public and domestic purposes.</td>
<td>Remedy surface soil impacts. Routing of surface water to containment for land use application. LUR to be put in place to maintain existing surface pavement or equivalent substitute. Restrict excavation and require proper management of excavated soil.</td>
</tr>
<tr>
<td>Area A – Sandstone Hill Shallow Groundwater</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>See “Groundwater Containment System Enhancements” – Interception and off-site migration control via the existing groundwater containment system of interceptor trenches, French drain, and pumping wells. Site-wide LURs would be required to prohibit the installation of drinking water wells for public and domestic purposes.</td>
<td>Remedy surface soil impacts. Routing of surface water to containment for land use application. LUR to be put in place to maintain existing surface pavement or equivalent substitute. Restrict excavation and require proper management of excavated soil.</td>
</tr>
<tr>
<td>Area D – Operations Area</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Continued operation, maintenance, and monitoring of the existing interceptor trenches, French drain, and pumping wells, with disposal of water through land application.</td>
<td>LUR to be put in place to maintain existing surface pavement or equivalent substitute. Restrict excavation and require proper management of excavated soil.</td>
</tr>
<tr>
<td>Preferred Alternative</td>
<td>Surface Soil</td>
<td>Subsurface Soil</td>
<td>Groundwater</td>
<td>Surface Water</td>
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</tr>
<tr>
<td>PRIMARY REMEDIAL PRIORITIES – CRS Unit</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRS Unit Monitoring and Closure</td>
<td>Not applicable.</td>
<td>Continued Post-Closure Care monitoring under reduced schedule authorized by KDHE. Monitoring to continue until pH condition meets closure requirements. Existing deed notice to remain in place pending RCRA closure.</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>LURs to be put in place:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Site-wide restriction on residential use of property.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Site-wide prohibition on installation of groundwater wells for drinking water use.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRIMARY DEVELOPMENT PRIORITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Water Management</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Management and monitoring of storm water to continue as outlined in the SMP for an assumed period of 8 years. After 5 years, or upon sale of the property for redevelopment, construction of a drainage ditch, berm, weir structure, and detention basin using a pump to facilitate drainage from the detention basin. Desludging of the East and West Effluent Ponds for use as detention basin to be performed separately from the final closure of the Northern Ponds.</td>
</tr>
<tr>
<td>Secondary Remedial Priorities</td>
<td>Preferred Alternative</td>
<td></td>
<td></td>
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<tr>
<td>-------------------------------</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Surface Soil</strong></td>
<td><strong>Subsurface Soil</strong></td>
<td><strong>Groundwater</strong></td>
<td><strong>Surface Water</strong></td>
<td></td>
</tr>
<tr>
<td>Area A – UAN Storage Area</td>
<td>Limited removal of highly impacted surface soils, on-site disposal of soils in Area B ponds, and backfill with on-site soils.</td>
<td>Natural attenuation.</td>
<td>Not applicable. See “Groundwater Containment System Enhancements”</td>
<td></td>
</tr>
<tr>
<td>Sandstone Hill Soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Ponds Soils</td>
<td>Removal of top 3 feet of soil, and on-site disposal of soil in Area B ponds.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>Dam Pond Sediments</td>
<td>Removal of sediments from within the footprint of the pond, with disposal in Area B ponds. LUR to be put in place to protect the pond from erosion, removal, or bypass.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>Krehbiel and West Ponds</td>
<td>After surface water quality has improved sufficiently, remove sumps and dike between ponds and direct water flow to main effluent ditch.</td>
<td>Not applicable.</td>
<td>Monitor water quality to determine when ponds can be removed.</td>
<td></td>
</tr>
<tr>
<td>Area B Ponds – West Extension Pond</td>
<td>Removal of contaminated sediments with disposal in on-site consolidation pond. Backfill, placement of soil cap, and seed. LUR to limit the type of construction on top of the ponds without the performance of appropriate geotechnical analysis and material augmentation.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>Preferred Alternative</td>
<td>Surface Soil</td>
<td>Subsurface Soil</td>
<td>Groundwater</td>
<td>Surface Water</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
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</tr>
<tr>
<td>Area B Ponds – West Effluent and East Effluent Ponds</td>
<td>Removal of contaminated sediment/sludge with disposal in on-site consolidation pond.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Area B Ponds – West Lime and Rundown Ponds</td>
<td>To be used for consolidation of contaminated soils and sediments from other parts of the Site. Upon completion of consolidation activities, placement of soil cap and seed.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td></td>
<td>LUR to limit the type of construction on top of the ponds without the performance of appropriate geotechnical analysis and material augmentation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area B Ponds – East Lime Pond</td>
<td>To be used for consolidation of contaminated soils and sediments from other parts of the Site. Upon completion of consolidation activities, placement of soil cap and seed.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td></td>
<td>LUR to limit the type of construction on top of the ponds without the performance of appropriate geotechnical analysis and material augmentation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area B Ponds – Overflow Pond</td>
<td>To be used for containment of nitrogen-contaminated storm water pending disposal through land application.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>
## Preferred Alternative

<table>
<thead>
<tr>
<th></th>
<th>Surface Soil</th>
<th>Subsurface Soil</th>
<th>Groundwater</th>
<th>Surface Water</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A and Area D Soils</td>
<td><strong>See Primary Remedial Priorities.</strong>&lt;br&gt;Soil disturbed by redevelopment to be managed according to soil management plan.</td>
<td><strong>See Primary Remedial Priorities.</strong>&lt;br&gt;Soil disturbed by redevelopment to be managed according to soil management plan.</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>Production Wells</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
<td>Plugging and abandonment of seven productions wells if not sold with property.</td>
<td>Not applicable.</td>
<td></td>
</tr>
</tbody>
</table>
8.2 SUMMARY OF HISTORICAL COSTS

This section summarizes the historical costs for remedial, monitoring and maintenance activities performed at the Site. The following table includes a summary of the historical tasks that have occurred from 2004 through 2007 and the total costs for each respective year. It should be noted that 2004 was the year that the Trust retained Shaw to conduct remedial, monitoring and maintenance activities.
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Conceptual Modeling and Report</td>
<td>Developed Site Conceptual Model and Recommendations Report for soil, groundwater and storm water issues.</td>
<td>$45,000</td>
</tr>
<tr>
<td><strong>Total for 2004</strong></td>
<td></td>
<td>$45,000</td>
</tr>
<tr>
<td><strong>2005</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Characterization Planning Documents and FBR Design</td>
<td>Conducted 30% design of a Fluidized Bed Reactor water treatment system for nitrate impacted waters. Prepared planning documents for 2005 Site Characterization.</td>
<td>$97,000</td>
</tr>
<tr>
<td>Site Characterization Activities and Meetings</td>
<td>Conducted site characterization activities per the KDHE-approved work plan and attended meetings with KDHE.</td>
<td>$480,000</td>
</tr>
<tr>
<td>Land Application</td>
<td>Conducted site characterization activities per the KDHE-approved work plan and attended meetings with KDHE.</td>
<td>$127,000</td>
</tr>
<tr>
<td>CRS Unit</td>
<td>Evaluated and selected a remedial option for groundwater pH neutralization at the CRS Unit.</td>
<td>$30,000</td>
</tr>
<tr>
<td>Land Application</td>
<td>Land application construction activities including pipeline repairs and testing and equipment purchase and installation.</td>
<td>$127,000</td>
</tr>
<tr>
<td>Waste Disposal</td>
<td>Transportation, bulking and disposal of various waste materials.</td>
<td>$20,000</td>
</tr>
<tr>
<td>Asbestos Removal</td>
<td>Removal and disposal of ACM at various plant locations. These activities were funded from the Administrative Trust. Costs are shown for reference only and are not included in the 2005 total or the total historical costs. These totals represent Remediation Trust expenses only.</td>
<td>$1,000,000</td>
</tr>
<tr>
<td><strong>Total for 2005</strong></td>
<td></td>
<td>$754,000</td>
</tr>
<tr>
<td>Task</td>
<td>Description</td>
<td>Total Cost</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>2006</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Plans and Dewatering</td>
<td>Preparation of letter work plans for various interim actions and dewatering activities. Included dewatering of the East and West Lime Ponds and the Oil Spill Pond.</td>
<td>$35,000</td>
</tr>
<tr>
<td>Supplemental Sampling</td>
<td>Additional soil and groundwater sampling for nitrogen compounds north of the Site.</td>
<td>$20,000</td>
</tr>
<tr>
<td>CRS Unit</td>
<td>Construction of potable water injection system including system O&amp;M and reporting.</td>
<td>$45,000</td>
</tr>
<tr>
<td>Interim Remedial Actions</td>
<td>Conducted interim remedial actions at the Central Ponds, West Pond, Krebbiel Pond, Oil Pond, Spill Pond and Catalyst Landfill.</td>
<td>$252,200</td>
</tr>
<tr>
<td>Pipe Rerouting</td>
<td>Modified the groundwater control systems including two interceptor trenches.</td>
<td>$55,200</td>
</tr>
<tr>
<td>Topographic Survey and Grading Plan</td>
<td>Conducting a topographic survey of Area B (Northern Ponds) and immediate areas surrounding the Northern Ponds including 43 monitoring wells. Conducted a conceptual grading plan of Area B.</td>
<td>$130,000</td>
</tr>
<tr>
<td>Area B Pond Closure Work Plan</td>
<td>Prepared a work plan detailing the activities to be performed during the closure of the Northern Ponds.</td>
<td>$27,000</td>
</tr>
<tr>
<td>Land Application</td>
<td>Land application O&amp;M activities and letter reports.</td>
<td>$45,000</td>
</tr>
<tr>
<td>2006 General O&amp;M</td>
<td>NPDES/storm water monitoring, North End Corrective Action monitoring, RCRA Corrective Action monitoring and laboratory certification.</td>
<td>$50,000</td>
</tr>
<tr>
<td><strong>Total for 2006</strong></td>
<td></td>
<td><strong>$659,400</strong></td>
</tr>
<tr>
<td>Task</td>
<td>Description</td>
<td>Total Cost</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Monitoring Well Replacement, Rehabilitation and Abandonment</td>
<td>Installation (replacement), abandonment and rehabilitation of monitoring wells confirmed by the KDHE. Included the abandonment of 57 wells, installation of five (5) wells, repair and rehab of six (6) wells and grouting of a 20-ft stainless steel water line.</td>
<td>$155,000</td>
</tr>
<tr>
<td>Pond Decommissioning Planning</td>
<td>Prepared planning documents for decommissioning of Northern Ponds and conducted meetings with KDHE.</td>
<td>$100,000</td>
</tr>
<tr>
<td>AST #5 &amp; #6 Standing Water</td>
<td>Planning and field activities associated with providing adequate drainage to an area of ponding water located between AST #5 and #6.</td>
<td>$37,500</td>
</tr>
<tr>
<td>Tank Inspection, Repairs and Closure</td>
<td>Inspection and repairs of AST #6; clean-out of Imhoff Tank; and abandonment of one septic tank.</td>
<td>$332,000</td>
</tr>
<tr>
<td>Area A Hill Geologic Study</td>
<td>Planning and field activities associated with evaluating the hydrogeology/geology of the Area A Hill and how the characteristics affect the drainage of subsurface water from the area.</td>
<td>$70,000</td>
</tr>
<tr>
<td>Mapping of Major Process Lines</td>
<td>Reviewed historical documents, identified and mapped the major subsurface process lines.</td>
<td>$8,000</td>
</tr>
<tr>
<td>Supplemental Soil Investigation</td>
<td>Conducted a soil investigation at select areas within the footprints of the ammonia plant, urea plant and the former cooling towers.</td>
<td>$50,000</td>
</tr>
<tr>
<td>CRS Unit O&amp;M and Modifications</td>
<td>Constructed a sodium bicarbonate injection system. Task included system O&amp;M and reporting.</td>
<td>$45,000</td>
</tr>
<tr>
<td>Cooling Tower Demolition</td>
<td>Demolished and removed cooling towers at the ammonia, nitric acid and urea plants.</td>
<td>$340,000</td>
</tr>
<tr>
<td>Land Application</td>
<td>Land application O&amp;M activities and letter reports.</td>
<td>$55,000</td>
</tr>
<tr>
<td>2007 General O&amp;M</td>
<td>NPDES/storm water monitoring, North End Corrective Action monitoring, RCRA Corrective Action monitoring and laboratory certification. Also included replacement of 1,600 ft of 4&quot; HDPE piping associated with pumping wells PSW-3B, PSW-6B, PSW-7B.</td>
<td>$130,000</td>
</tr>
<tr>
<td>Overflow Pond Sediment Removal, West Pond Sump Installation, and Piping to Overflow Pond</td>
<td>Excavation of 15,154 cubic yards of sediment from the Overflow Pond and placement into the Rundown Pond. Installation of a sump, pump, and piping in West Pond to manage impacted water entering the pond, and installation of piping to manage and transport impacted surface water coming off the south of the Sandstone Hill to the Overflow Pond.</td>
<td>$407,400</td>
</tr>
<tr>
<td>Remedial Action Plan</td>
<td>Prepared a RAP summarizing all previous investigative work, all interim corrective measures and planned future corrective measures to be performed at the Site.</td>
<td>$75,000</td>
</tr>
<tr>
<td>CRS Unit Interim Remedial Measures Plan</td>
<td>Gathered subsurface data and developed an IRM Plan outlining alternative options for in-situ and ex-situ pH adjustment and increasing hydraulic conductivity.</td>
<td>$25,000</td>
</tr>
<tr>
<td><strong>Total for 2007</strong></td>
<td></td>
<td><strong>$1,829,900</strong></td>
</tr>
<tr>
<td><strong>Total Historical Costs</strong></td>
<td></td>
<td><strong>$3,288,300</strong></td>
</tr>
</tbody>
</table>
8.3 FUTURE COSTS

An analysis of future costs associated with remedial, monitoring, and maintenance activities to be performed at the Site has been prepared and is presented in Figure 8-2. Further details on the implementation strategy are provided in Section 8.4.

Based on the funding limitations in the Remediation Trust, the various regulatory agencies have prioritized the remedial activities that need to be implemented. Primary remedial priorities were identified and include the following:

- Continued operation and enhancement of the groundwater monitoring network
- Continued operation and enhancement of the groundwater containment system at the site including land application of impacted water for a minimum of 30 years
- Land-use controls recorded and filed with the County Register of Deeds Office to control future uses and activities at the Site.
- Continued Post-Closure Care monitoring of the CRS Unit in accordance with the requirements of the KDHE Bureau of Waste Management.

Primary development priorities were also identified and will be implemented in coordination with future development of the Site or if the property is not sold within five years by funding from the Administrative Trust. These development priorities include the following:

- Modification of infrastructures by desludging the East and West Effluent Ponds, re-routing the primary storm water drainage channel, and constructing a detention basin.
- Operation of the detention basin (pump assisted drainage) for the remaining balance of the 30 year project life and maintenance of current NPDES requirements.
- Payment of RCRA annual permit fees associated with the CRS unit.

Several secondary remedial priorities were also identified which will be required to achieve final closure of the site. These priorities will be performed as part of a financial assurance mechanism which will be required of potential purchasers of the Site. The secondary priorities include excavation and management of impacted soils to improve storm water runoff quality or to accommodate future development as follows:

- Impacted soil excavation from the Sandstone Hill.
- Impacted soil excavation from the Central Ponds.
- Impacted sediment excavation from the Dam Pond.
- Maintenance on the remaining ponds in the storm water system (Krehbiel and West Ponds).
- Final closure of the northern ponds, including the Overflow Pond.
- Impacted soil excavation from the Urea Plant area to allow for the installation of utilities or foundations as part of development.
• Impacted soil excavation from the Northeast Production area to allow for the installation of utilities as part of development.
• Site production water well plugging and abandonment.
• Submittal of remedial design proposals as the property is developed to address specifics of the secondary priorities if they differ from those presented in this RAP.

The analysis of future costs presented in Figure 8-2 is organized to match the priorities established by the regulatory agencies. The implementation strategy for these remedial actions will include the competitive bidding of services required to complete the actions in the most cost-effective manner. Economies of scale may also assist in obtaining cost-effective pricing through the packaging of several tasks into a competitive bid package. The total estimated costs to achieve long-term closure of the Site as of May 22, 2009 are $13,231,402.

The three primary remedial priorities will be funded from the Remediation Trust. As illustrated on Figure 8-2, the total estimated future costs associated with these three priorities as of May 22, 2009 are $5,116,105. The remaining balance in the Remediation Trust as of April 30, 2009 is approximately $4,314,894.

Estimate future costs for the remaining priorities as of May 22, 2009, including a contingency on all estimated costs and KDHE oversight costs, total $8,115,297. The overage will be covered in the form of financial assurance from potential future purchasers of the Site in this amount.

It should be noted that the total site costs do not take into account final demolition or Site development plans. Site development can be coordinated with remedial efforts to reduce the overall remedial costs. Site development can also help improve Site conditions in a quicker fashion that have been estimated in this RAP which can reduce long-term operation and maintenance costs over the 30-year project life.

8.4 IMPLEMENTATION STRATEGY

In order to efficiently implement the remedial strategies outlined in Section 7, a phased approach will be used. The first phase will include the on-going operation and maintenance of the groundwater monitoring network, groundwater containment system and associated land application of impacted waters for a minimum period of 30 years. This will include the installation of enhancements to the groundwater containment system including a sump to transfer surface water from the Dam Pond to the ASTs for land application and the installation of an interceptor trench in the vicinity of the Central Ponds to capture groundwater that daylights as seeps in this area. The water captured by the interceptor trench will be gravity piped to the Overflow Pond for future land application. These activities will also help shorten the amount of time required to clean up the groundwater.

NPDES storm water monitoring will also be performed in the first phase in accordance with the July 2006 storm water management plan to ensure compliance with the existing NPDES permit. Storm water monitoring will be required, at a minimum, until the East and West Effluent Ponds are desludged and the new storm water drainage ditch is constructed. As these two activities are considered Site development priorities, it is assumed in this RAP that storm water monitoring will continue for a period of 8 years. After 5 years, if a Site development plan has not been prepared,
the desludging of the East and West Effluent Ponds and the construction of the new storm water drainage ditch may be funded out of the Administrative Trust so that long-term storm water monitoring can be eliminated and the NPDES permit terminated. However, it is hoped that a development plan will exist at that point in time so the storm water needs of the development can be evaluated against the conceptual designs of the new storm water drainage ditch and detention basin.

LURs will also be placed during the Phase I to restrict certain activities and uses of the Site. Post-Closure Care monitoring of the CRS Unit is also included in Phase I. It has been assumed that the monitoring of the CRS Unit will be performed for 12 years. However, the Post-Closure Care monitoring can be terminated once the pH of the groundwater in the area of the CRS Unit has met the closure requirements.

Phase II will include the desludging of the East and West Effluent Ponds and the construction of the new storm water drainage ditch and detention basin. Subsequent to the construction of the new ditch and detention basin, Phase II will also include the operation and maintenance of the detention basin which will use a pump to assist in rapid drainage of the basin during high flow events.

At this time, Phase II activities are not anticipated to occur before the fifth year. The purpose for this timeline is to provide time for the transaction of the Site and a development plan for the Site to be prepared. Once a development plan has been prepared for the Site, the storm water management requirements for the development can be evaluated against the conceptual designs of the new storm water ditch and detention basin to ensure the structure is sufficient to meet the needs of the development. If a development plan has not been prepared by the fifth year, these activities may be performed using funding from the Administrative Trust so that long-term expenses associated with storm water monitoring and maintaining the NPDES permit can be eliminated.

Phase III will include the performance of the secondary remedial priorities if funding becomes available from the Remediation Trust, through required financial assurance from the prospective purchaser or through other Site development activities. The timing of these activities will be based on Site development activities as well as the successful completion of primary remedial priorities.

Implementation of the remedial strategies will commence upon final approval of this RAP by KDHE. Final approval of the RAP is anticipated to be received in 2009. Figure 8-2 is also intended to provide a projected implementation schedule. It should be noted that the schedule for the development priorities and the secondary priorities may change depending upon Site development activities.
9.0 Conclusions

Shaw Environmental and Infrastructure, Inc. was retained by the FI Kansas Remediation Trust to prepare a comprehensive Remedial Action Plan for the former Farmland Industries Nitrogen Plant in Lawrence, Kansas. The objective of the Remedial Action Plan is to provide a comprehensive plan for completion of the final stages of remedial action at the Site.

The former nitrogen plant began operations in 1954 and has been inactive since its closure in 2001. The plant was expanded and updated during its history to provide a variety of nitrogen fertilizer products, including anhydrous ammonia, nitric acid, granular urea, ammonium nitrate, and urea ammonium nitrate (UAN) solution. The Site encompasses an area of 467 acres and is bounded on the north by 15th Street and the Burlington Northern Santa Fe Railroad. The remaining Site property lines border undeveloped and developed commercial property on the east, mixed industrial and residential area on the west, and State Highway K-10 on the south.

The Site has undergone several episodes of environmental investigation since the 1970’s. The results of these investigations have led to the performance of various interim remedial measures at the Site from the late 1970’s through 2007. The Remedial Action Plan provides a summary of the previous environmental investigations and remediation-related activities, identification of environmental issues that require further action, an evaluation of remedial alternatives, and identification of proposed actions and rough order-of-magnitude costs for the proposed actions.

Based on the current land use of the Site as industrial, and the proposed land-use controls to limit residential zoning at the site, the Remedial Action Plan identified approximately 302 acres of the Site as requiring no further active remedial measures. However, these areas will be subject to specific land-use restrictions.

The remaining areas of the Site requiring active remedial measures primarily include Area A and Area B. In addition, the existing groundwater containment system and land application program will be maintained for a period of 30 years to control off-site migration of nitrate impacted groundwater.

The overall remediation goal for the Site is full closure and unrestricted property use. However, given the nature, extent, and depth of impacts, it is not possible to implement a remedial strategy which achieves the site closure goal in the near term within the funding limitations of the Trust. For this reason, KDHE, USEPA, and the Trust have prioritized the remedial activities that need to be implemented to control future migration of impacts from the Site. While this strategy is limited in scope because of the funding limitations, it is protective of human health and the environment and will allow future redevelopment of the Site.

Following acceptance of the Remedial Action Plan by the Kansas Department of Health and Environment, the Remedial Action Plan will be provided for public review and comment. Following the public review and comment period, the Remedial Action Plan and schedule will be finalized and the proposed actions implemented.
Figures
Appendix A

Documentation of Original Landfill
(Provided to KDHE in March 2008)
Appendix B

Closed Landfill Deed Restrictions
Appendix C

Copies of Previous Reports (on CD)
Appendix D

USEPA Memorandum
December 1, 2008
Appendix E

One Dimensional Consolidation Testing Results – West Lime Pond, Rundown Pond, East Lime Pond